THE PRINCIPLES AND PRACTICE OF DENTAL SURGERY,

BY

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EIGHTH EDITION:

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Dedication to the Seventh Edition.

TO

THOMAS E. BOND, M. D.,

PROFESSOR OF SPECIAL PATHOLOGY AND THERAPEUTICS IN THE BALTIMORE COLLEGE OF DENTAL SURGERY,

AS A TOKEN OF GRATITUDE FOR MUCH KINDNESS, AND AS A TESTIMONY OF RESPECT AND ESTEEM FOR GREAT PROFESSIONAL AND PRIVATE WORTH,

THIS VOLUME

IS RESPECTFULLY DEDICATED,

BY HIS FRIEND,

AND OBEDIENT SERVANT,

THE AUTHOR.

PUBLISHERS' PREFACE

TO THE EIGHTH EDITION.

The Publishers, in preparing this, the first posthumous edition of the late President Harris' Principles and Practice of Dental Surgery, have spared no pains to make it in every way worthy of its own high reputation and that of its distinguished Author.

It has been subjected to a very thorough revision by competent professional gentlemen, and will be found to contain many and important additions, bringing the work fully up to the present state of Dental Science and Art.

The Publishers desire to acknowledge the valuable assistance rendered by Professor Austen, to whom they are indebted for the entire chapter on Vulcanite, most of the chapter on Soldering, and much new matter, in the chapter on Irregularity, and throughout the entire Mechanical Division of the work. They would also acknowledge important additions by Prof. Christopher Johnston, of the Baltimore College; a valuable section on artificial Palates by Dr. Wm. H. Dwinelle, and a number of useful practical suggestions from Dr. Edward Maynard.

The illustration of the work has been greatly improved. A few unimportant designs have been omitted; several others have been replaced by improved drawings and

many new illustrations have been added, for a large number of which they are indebted to the courtesy of Dr. Samuel S. White.

The Publishers lay this edition before the Profession in the confident assurance that it will be found to be what its Author designed it,—a thorough elementary treatise, a text-book for the student, and a useful companion and guide for the practitioner.

PHILADELPHIA, *Sept.* 1, 1863.

PREFACE

TO THE SEVENTH EDITION.

In revising his Principles and Practice of Dental Surgery for a Seventh Edition, the author trusts that no abatement of effort will be discovered on his part to render it every way worthy of a continuance of the approbation it has hitherto received. Nearly every page has been carefully revised, and additions have been introduced throughout the entire work. Three new chapters and a number of new illustrations have also been added. In short, he believes that no valuable improvement or discovery, coming within the scope of this work, has been omitted in the present edition.

CHAPIN A. HARRIS.

No. 51 North Charles St.,
Baltimore, *Sept.* 1858.

PREFACE

TO THE SECOND EDITION.

In submitting to the profession a Second Edition of his Dental Practice, the author is happy to avail himself of the opportunity to express his grateful appreciation of the approbation which the First has received. He trusts that the additions which he has made to the primary work will make the one now presented still more acceptable. The alteration in the plan, which has resulted from the effort at improvement, has, however, rendered a slight change of title necessary, in order to express the character of the present book.

In the First Edition, the Anatomy of the Mouth was omitted, because a thorough knowledge of it can be obtained from works on General Anatomy. But it has been suggested that such works may not be at hand when wanted by the dental student, and the author has thought it better to furnish a description of the several structures which enter into the formation of this cavity. He has, however, confined himself to brief expositions of the parts; not wishing to encumber the work, or distract the student with the consideration of matters foreign to the purpose for which it was written, and for which he trusts, it will be read. He is indebted to Bourgery's Anatomy, Quain

and Wilson's Anatomical Plates, Wilson's Anatomy, and Smith and Horner's Anatomical Atlas, for a number of the illustrations used in this part of the work.

The Second and Fifth Parts embody the substance of two papers, by the author, which were written subsequently to the publication of the first edition. The subjects of them came properly within the plan of the present work.

The object of the author in the preparation of this edition has been to provide a thorough elementary treatise on Dental Medicine and Surgery, which might be a text book for the student and a guide to the more inexperienced practitioner; and he hopes that the modifications he has introduced, and the additions he has made, will entitle it to be so considered, at least, until an abler hand shall prepare a better.

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CHAPTER FIRST.

PART FIRST.

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PART FIRST.

ANATOMY AND PHYSIOLOGY OF THE MOUTH.

The Mouth, *cavum oris*, signifies in the human subject, the space included between the palatine arch *above*, the mylo-hyoid muscles *beneath*, the lips in *front*, the velum palati *behind*, and the cheeks on *either side*. The teeth and closed jaws separate the inner portion, or lingual cavity, from the outer, or vestibular space; and while that part of the latter bounded by the cheeks ought properly to bear the appellation *buccal*, the term *buccal cavity* is not unfrequently employed with a signification so general as to comprehend the whole oral cavity.

In the mouth are the tongue, teeth, and the alveolar ridges invested by the gums: into it are poured the secretion of the parotid, sub-maxillary and sub-lingual glands, as well as that of the ordinary mucous and of the special lingual follicles; and in it the food is subjected to the processes of mastication and insalivation previous to deglutition.

It is farther concerned in the prehension of aliment; and besides containing the organs of taste, is employed in articulation, expectoration, suction, &c.

The parts concurring to constitute the mouth, form a very complicated piece of mechanism; through them it has a wide range of sympathies, and by them performs a great variety of functions.

The anatomical elements composing these parts, consist of Bone, Ligament, Muscle, Gland, Blood-vessel, Nerve, Areolar and Adipose tissues and Mucous membrane.

These different elements combine together and form the various organs which constitute the mouth.

These organs I shall consider in their physiological order; thus combining their anatomy and physiology, studying at the same time both their healthy structure and function—a plan practically taught by the late Professor W. R. Handy, in the Baltimore College of Dental Surgery, and which commends itself as at once the most natural, interesting and instructive.

CHAPTER FIRST.

ORGANS OF PREHENSION.

THIS class of organs may be said to commence the digestive process, and it comprises those which seize the food, and introduce and partly retain it in the mouth.

FIG. 1. A front view of the muscles of the face: *a a* Anterior bellies of occipito-frontalis; *b b* Orbicularis palpebrarum; *c* Pyramidalis nasi; *d* Compressor nasi; *e e* and *f f* Levator labii superioris alæque nasi; *g g* Zygomaticus minor; *h h* Zygomaticus major; *i i* Masseter muscle; *j j* Buccinator, or trumpetor's muscle; *k k* Orbicularis oris; *l l* Depressor labii inferioris; *m* Levator menti; *n n* Depressor anguli oris; *o o* Levator anguli oris.

They consist of the Elevators, Depressors, and Sphincter muscles of the mouth, which are as follows:

1. Levator labii superioris alæque nasi.
2. Levator anguli oris.

These two muscles elevate the upper lip and the angle of the mouth.

3. Depressor labii inferioris—or quadratus menti.
4. Depressor anguli oris—or triangularis oris.

These two muscles antagonize the first and depress the lower lip and angles of the mouth.

5. Zygomaticus major.
6. Zygomaticus minor.
7. Buccinator.

These extend from the angles of the mouth to the prominence

of the cheek. Their use is to draw the angles of the mouth upwards and outward towards the ear.

8. Orbicularis oris.

This is the sphincter muscle which surrounds and closes the mouth.

9. Depressor labii superioris.

10. Levator labii inferioris.

The first depresses the upper lip against the teeth—the other raises the lower lip.

ORIGIN AND INSERTION OF THESE MUSCLES, OR THEIR ATTACHMENTS.

1. *Levator Labii Superioris Alœque Nasi*, arises by two heads: first from the nasal process of the superior maxillary bone; second, from the edge of the orbit above the infra-orbital foramen. It is inserted into the ala nasi or wing of the nose and upper lip.

2. *Levator Anguli Oris*, arises from the canine fossa of the superior maxillary bone, immediately below the infra-orbital foramen. It is inserted narrow into the angle of the mouth.

3. *Depressor Labii Inferioris*, arises from the side and front of the inferior maxilla at its base, and is inserted into the greater part of the lower lip.

4. *Depressor Anguli Oris*, arises broad and fleshy from the base of the lower jaw at the side of the chin. It is inserted into the angle of the mouth.

5. *Zygomaticus Major*, arises long and narrow from the malar bone, near the zygomatic suture. It is inserted into the angle of the mouth.

6. *Zygomaticus Minor*, arises from the front part of the malar bone, and is inserted into the upper lip, above the angle of the mouth.

This muscle is sometimes wanting, and is occasionally a simple slip from other muscles.

Buccinator, arises from the pterygo-maxillary ligament, and from the alveolar margin of upper and lower maxillary bones as far anteriorly as the first molar or last bicuspid tooth. Its fibres are inserted into, or become confluent with, those of the *orbicularis oris*.

8. *Orbicularis Oris*. This muscle has no bony attachments: it is circular, surrounds the mouth, and consists of two layers of fibres; one for the upper, the other for the lower lip, which meet at the angle of the mouth.

9. *Depressor Labii Superioris*, arises from the alveolar processes of the incisive and canine teeth; and is inserted into the upper lip and side of the ala nasi.

10. *Levator Labii Inferioris*, arises from the alveolar processes of the incisive teeth of the lower jaw. It is inserted into the lower lip and chin.

See Organs of Mastication for a description of the bones connected with these muscles.

CHAPTER SECOND.

ORGANS OF MASTICATION.

Mastication, as the term implies, is a process of chewing or minutely dividing the food, when introduced into the mouth; and the organs under this head are the agents or instruments which effect this operation.

The organs of mastication are divided into, 1st. The passive: 2d. The active.

PASSIVE ORGANS OF MASTICATION.

The passive organs include the bones, ligaments and teeth. The principal bones are,

1. The superior maxillary or upper jaw bones.
2. The inferior maxillary or lower jaw bone.
3. The palate bones.

THE SUPERIOR MAXILLARY BONES.

The *Superior Maxillary Bones*, two in number, are in pairs and united on the median line of the face. They occupy the anterior upper part of the face, are of very irregular form, and consist of a body and processes.

The body is the central part of the bone and has four surfaces, namely, the anterior or facial, the posterior or pterygoid, the superior or orbital, and the inferior or palatine.

The *Anterior Surface* is irregularly convex, and has a depression about its centre just above the canine and first bicuspid teeth, called the canine fossa: immediately above which is the infra-orbital foramen for transmitting an artery and nerve of same name: its upper and inner edge forms part of the lower margin of the orbit, from the inner extremity of which proceeds upward towards the nasal and frontal bones a long and rather flat process, having a pyramidal form—the nasal process of the superior maxilla: its posterior edge forming the internal margin

of the orbit and helping to form the lachrymal groove; its anterior edge receives the cartilages of the nose; its upper cor-

Fig. 2.

Fig. 3.

Fig. 2. *a* The body of the left superior maxilla; *b* Canine fossa; *c* Infra-orbital foramen; *d* Incisive fossa; *e* Harmonial suture of the two bones; *f* Nasal spine; *g* Semilunar notch of anterior nares; *h* Nasal process; *i* Articulation with lachrymal bone; *j* Malar process; *k* Tuberosity of superior maxilla; *l* Cavity of the antrum; *m* Lachrymal tubercle; *n* Orbital process.

Fig. 3. *a* Nasal surface of left superior maxilla; *b* Opening of antrum; *c* Inferior turbinated bone; *d* Inferior meatus of nose into which the nasal duct opens; *e* Nasal process; *f* Semilunar notch of lachrymal bone; *g* Nasal spine; *h h* Palate process; *i i* Alveolar process; *j* Horizontal plate of palate bone; *k* Palate spine; *l* Tuberosity of palate bone; *m* Hamular process.

responds to the nasal bones, and its summit to the frontal; while its outer surface gives attachment to muscles, and its inner enters into the formation of the nose.

Fig. 4.

From the lower edge of its *anterior surface*, the alveolar processes and cavities are formed: these consist in depressions of a more or less conical form, and correspond to the number of teeth, or roots of teeth, which they are intended to receive. See Fig. 4.

The bottom of each of these cavities is perforated by a small foramen, for the passage of nerves and blood vessels which supply the teeth. The alveolar border externally presents a fluted appearance; the projections correspond with the alveolar cavities, and the depressions with the septa which divide them from one another.

The *Posterior Surface* has a bulging, called tuberosity, which

is connected with the palate bones, and bounds the antrum behind; it is perforated by three or four small holes—the posterior dental canals which transmit nerves and blood vessels to the molar teeth.

The *Lower Surface* extends from the alveolar processes in front to the horizontal plate of the palate bones behind, called the palatine processes, which are rough below, forming the roof of the mouth, and smooth above, making the floor of the nostrils. They are united along the median line, at the anterior part of which is the foramen incisivum, having two openings in the nares above, while there is but one in the mouth below.

The *Upper or Orbital Surface* is triangular in shape, with its base in front forming the anterior, lower and internal edge of the orbit; while its apex extends back to the bottom, forming the floor of the orbit and roof of the antrum; its internal edge is united to the lachrymal, ethmoid, and palate bones; its external edge assists in forming the spheno-maxillary fissure, and along its central surface is seen a canal running from behind, forward and inward—the infra-orbital canal. This canal divides into two: the smaller is the *anterior dental*, which descends to the anterior alveoli along the front wall of the antrum; the other is the proper continuation of the canal and ends at the infra-orbital hole; along the upper part of the line uniting the palatine processes there is a ridge, the *nasal crest*, for receiving the vomer, and at the anterior part of this crest there is a forward projection, the *nasal spine;* at the external and upper part of the body is the *malar process*, which articulates with the malar bone. This point is opposite the summit of the maxillary sinus.

The body of the superior maxilla is occupied by a large and very important cavity called the *Antrum Highmorianum*, or Maxillary Sinus. This cavity is somewhat triangular in shape, with its base generally looking to the nose, and its apex to the malar process. Its upper wall is formed by the floor of the orbit, its lower by the alveoli of the molar teeth, which sometimes perforate this cavity. The canine fossa bounds it in front, while the tuberosity closes it behind. But the shape of this cavity is exceedingly variable. In examining a collection of

nearly one hundred maxillæ in the Museum of the Baltimore Dental College, no two sinuses were found to be shaped alike, and this difference is as marked between the right and the left in the same, as in different subjects. The floor of some is nearly flat, but in the majority of cases it is very uneven; sometimes crossed by a single septum, varying from one-eighth to half an inch in height; at other times there are found three or four septa, dividing the lower part of the cavity into as many separate compartments, with the bottom or floor of no two on a level with each other. Some are perforated by the roots of one or more teeth; at other times the roots of several teeth extend considerably above the level of the floor of the antrum covered by a lamina of bone scarcely thicker than bank note paper. In other cases, the floor of the antrum is half an inch above the extremities of the roots of the teeth. This cavity also varies as much in size as it does in shape.

The opening of the antrum is, on its nasal portion or base, into the middle meatus of the nose; in the skeleton it is large, while in the natural state it is much contracted by the ethmoid bone above, the inferior turbinated bone below, the palate bone behind, and by the mucous membrane which passes through the opening and lines the interior of the antrum.

The structure of the upper jaw, with its alveolar and numerous other processes, is thick and cellular; the cancellated structure being invested with a thin layer of compact bone.

It is articulated with two bones of the cranium, the frontal and ethmoid, and seven of the face, namely: the nasal, malar, lachrymal, palate, inferior turbinated, vomer, and to its fellow, by sutures; also to the teeth by the articulation termed *gomphosis.*

Its development commences at so early a period of intra-uterine life, and ossification proceeds so rapidly, that the number of ossific centres is uncertain: some give a centre for the body and each process, others think that most probably there are but four centres in all. It may be seen as early as the thirty-fifth or fortieth day after conception; and although at birth it has acquired but little height, it has increased considerably in breadth. But, at this period, the alveolar border, which constitutes the largest portion of the bone, is almost in contact with the orbit. The antrum is still scarcely perceptible, but as

the vertical dimensions of the bone are increased, it is gradually developed. With the loss of the teeth, the alveolar border nearly disappears, so that the vault of the palate loses its arched form, and sometimes becomes almost flat.

INFERIOR MAXILLARY BONE.

FIG. 5.

FIG. 5. The inferior maxilla: *a* Body of the bone; *b* Mental foramen; *c* The symphysis; *d d* Alveolar processes; *e* Ramus of the lower jaw; *f* Its angle; *g g* Coronoid processes; *h h* Sigmoid notch; *i i* Condyloid processes; *j j* Neck of the condyles; *k* Inferior dental foramen; *l* Mylo-hyoid ridge.

The *Lower Jaw*, Fig. 5, is the largest bone of the face, and though single in the adult, it consists of two symmetrical pieces in the fœtus.

It occupies the lower part of the face, has a parabolic form, and extends backwards to the base of the skull.

It is divided into a body and extremities.

The body is the middle and horizontal portion; this is divided along its centre by a ridge called the *symphysis*, which is the place of separation in the infant state; the middle portion projects at its inferior part into an eminence called the *mental process* or chin; on each side of which is a depression for the muscles of the lower lip, and externally to these depressions are two foramina, called *anterior mental*, for transmitting an artery and nerve of the same name.

The horizontal portions extend backward and outward; and

on the outward surface have an oblique line for the attachment of muscles.

On the inner surface of the middle part behind the chin, along the line of the symphysis, there is a chain of eminences called *genial processes;* to the superior of which the frenum linguæ is attached, to the middle the genio-hyo-glossi, and to the inferior the genio-hyoid muscles; on each side of these eminences are depressions for the sublingual glands; and beyond these depressions there runs an oblique ridge upward and outward, to the anterior part of which is attached the mylo-hyoid muscle, and to the posterior part, the superior constrictor of the pharynx; this latter muscle is consequently involved more or less in the extraction of the last molar tooth. Below this line there is a groove for the mylo-hyoid nerve.

The upper edge of the body is surmounted by the *alveolar processes* with cavities, corresponding in number and size to the roots of the teeth. (See Fig. 6.) The alveolar border, in the

Fig. 6.

fœtus, constitutes nearly the whole body of the bone. After the loss of the teeth, this part of the inferior maxillary is gradually wasted. The alveolar border, in the lower jaw, describes a rather smaller arch than it does in the upper, and both its anterior walls are thinner than the posterior.

The lower edge, called the *base*, is rounded and obtuse, and is invested by the superficial fascia and platysma-myoid muscle.

The extremities of the body have two large processes rising up at an obtuse angle, named the *rami* of the lower jaw. These processes are flat and broad on their surfaces; the outer one is covered by the masseter muscle; the inner one has a deep groove which leads to a large hole, the *posterior dental* or maxillary foramen, for transmitting the inferior dental nerves and vessels to the dental canal running along the roots of the teeth. This foramen is protected by a spine to which the spheno-maxillary ligament is attached.

The ramus has a projection at its lower part which is the angle of the lower jaw; its upper ridge is curved, having a process at each end—the anterior one is the *coronoid process;* this is triangular, and has the temporal muscle inserted into it; the posterior is the *condyloid*, and articulates with the temporal bone. This process has a neck which receives the insertion of the external pterygoid muscle.

The structure of the inferior maxilla is compact externally, cellular within, and traversed in the greater part of its extent by the inferior dental canal.

The lower jaw is developed from two centres of ossification, which meet at the symphysis. It articulates on each side by one of its condyles with the glenoid cavity of the temporal bone, situated at the base of the zygomatic process. This cavity is divided into two portions—an anterior and a posterior. The former constitutes the articular portion, the latter lodges a process of the parotid gland. The two are separated by the fissure of Glasserius, *fissura Glasserii*, which transmits the chorda tympani nerve, the laxator tympani muscle and the anterior tympanic artery. It also gives lodgement to the long process, *processus gracilis*, of the malleus.

Between this cavity and the condyle, there is interposed an interarticular cartilage, so moulded as to fit the two articular surfaces. The circumference of this being free, except where it adheres to the external lateral ligament and affords attachment to a few fibres of the external pterygoid muscle, facilitates the movements of the joint.

The union of this articulation is maintained by the external

lateral, the spheno-maxillary, and the stylo-maxillary ligaments. The external lateral is seen in Fig. 32.

THE PALATE BONES.

The palate bones, two in number, are situated at the back part of the superior maxillary bone, between its tuberosities and the pterygoid processes of the sphenoid bone. They are alike.

The palate bone is divided into three plates: the horizontal or palatine, the vertical or nasal, and the orbital.

The palate plate is broad and on the same line with the palate processes of the superior maxillary bone; its upper surface is smooth and forms the posterior floor of the nostrils, the lower surface is rough and forms the posterior part of the roof of the mouth; its anterior edge is connected with the palate process of the upper jaw, and its posterior is thin and crescentic, to which is attached the velum-pendulum palati or soft palate; at the posterior point of the suture, uniting the two palate bones, there projects backward a process called the *posterior nasal spine*, which gives origin to the azygos-uvulæ muscle. The *vertical plate* ascends, helps to bound the nasal cavity, diminishes the opening into the antrum by projecting forward, and by its external posterior part, in conjunction with the pterygoid processes of the sphenoid bone, forms the *posterior palatine canal;* the lower orifice of which is seen on the margin of the palate plate, and is called the *posterior palatine foramen*, transmitting the palatine nerve and artery to the soft palate; behind this foramen is often seen a smaller one, passing through the base of the pterygoid process of this bone, and sending a filament of the same nerve to the palate.

The upper end of the vertical or nasal plate has two processes—the one is seen at the back of the orbit, called the *orbital* process; the other is posterior and fits against the under surface of the body of the sphenoid bone. Between these two processes is a foramen, the *spheno-palatine*, which transmits to the nose a nerve and artery of the same name.

The palate bone articulates with six others, namely: the superior maxillary, inferior turbinated, vomer, sphenoid, ethmoid, and opposite palate.

The structure of this bone is very thin, and consists almost entirely of compact tissue. Its development, it is said, takes place by a single point of ossification at the union of the vertical, horizontal and pyramidal portions.

FIG. 7.

FIG. 8.

FIG. 7. Posterior view of the palate bone in its natural position, except that it is turned a little to one side so as to show the internal surface of its perpendicular plate; *a* Nasal surface of horizontal plate; *b* Nasal surface of perpendicular plato; *c k l* Pterygoid process or tuberosity; *d* Broad internal border of horizontal plate, which articulates with same border of opposite bone; *f* Process which unites with the same on the opposite side to form the nasal spine; *g* Horizontal ridge which gives attachment to inferior turbinated bone; *h* Spheno-palatine foramen; *i* Orbital portion; *j* Pterygoid apophysis.

FIG. 8. Spheno-maxillary surface of perpendicular plate of palate bone; *a* Its rongh surface, or the one which articulates with superior maxillary bone; *b* Part of the posterior palatine canal; *c* Spheno-palatine foramcn; *d* Spheno-maxillary facet; *e* Orbital facet; *f* Maxillary facet; *g* Sphenoidal portion of perpendicuiar p!ate; *h* Tuberoslty of the base or pterygoid process.

The bones of the Head are twenty-two in number, of which eight compose the cranium and fourteen the face. Those of the cranium are one frontal, two parietal, two temporal, one occipital, one sphenoid and one ethmoid. Those of the face arc six pairs and two single bones; the pairs are the two malar, two superior maxillary, two lachrymal, two nasal, two palatine and two inferior turbinated. The vomer and inferior maxillary are the two single bones.

THE TEETH.

The teeth are the prime organs of mastication, are the hardest portions of the body, and are implanted in the alveolar cavities of both the upper and lower jaw. Although analogous in structure to bone, they are regarded, by some, from their mode of development, as a modification of mucous membrane.

A tooth is composed of four distinct structures: 1. The *pulp*, occupying the chamber in the crown and the canal extending through the root; 2. The *dentine*, which constitutes the

principal part of the organ; 3. The *enamel*, which forms the covering and protection of the crown; 4. The *cementum* or *crusta petrosa*, which covers the root. (See Fig. 9.)

Fig. 9.

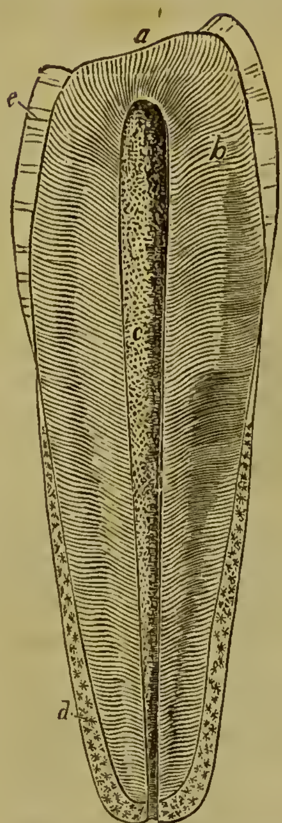


Fig. 9. *a* The coronal surface divested of enamel; *b* The dentine; *c* The pulp cavity; *d* The cementum, or crusta petrosa; *e* The enamel.

The teeth of first dentition, termed the milk, temporary, or deciduous teeth, are designed merely to supply the wants of childhood, and are replaced with a larger, stronger and more numerous set. These are termed the permanent or adult teeth, and are intended to continue through life.

The anatomical divisions of a tooth are: 1. The crown or exposed part situated above the gum; 2. The root occupying the alveolar cavity or socket; 3. The neck which is the constricted portion between the crown and root.

THE TEMPORARY TEETH.

The temporary teeth are divided into three classes: first, the incisors; second, the cuspids or canine teeth; third, the molars, which are succeeded by the biscuspids or premolars.

Fig. 10.

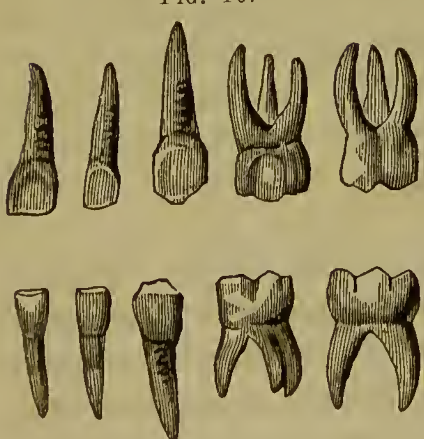


Fig 11.

Fig. 10. Front or labial view of the temporary teeth of the left side.
Fig. 11. Palatine or lingual view of these on the right side.

The temporary teeth are twenty in number, ten in each jaw, namely: four incisors, two cuspids, and four molars.

Fig. 12. Fig. 13.

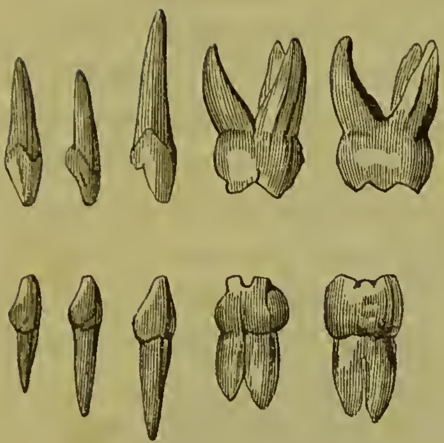


Fig. 12. Lateral or side view of temporary teeth.
Fig. 13. Section of ditto, exposing their pulp cavities.

The pulp cavity in a temporary tooth is larger in proportion to the size of the organ than in a permanent tooth.

THE PERMANENT TEETH.

There are thirty-two teeth in the permanent set, sixteen to each jaw—being an increase of twelve over the temporary, designated as follows: incisors, four; cuspids, two; bicuspids or premolars, four; molars, six—in each jaw. The third or last molar is sometimes denominated *dens sapientiæ* or wisdom tooth.

THE PULP.

The pulp, occupying the pulp cavity in the centre of the tooth, is the shrunken condition to which the tooth-germ is permanently

Fig 14. Fig 15.

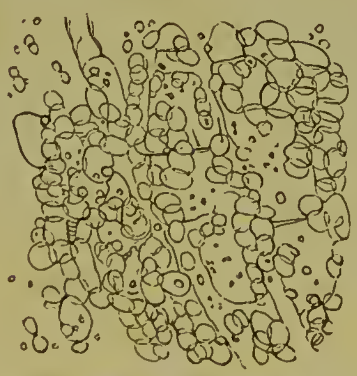


Fig 14. A portion of the body of the pulp, showing the cellular arrangement.
Fig. 15. A portion of the superficial layer of the pulp, showing the appearance of vesicles.

reduced after it has normally accomplished the work of dentinification. It is an exquisitively sensitive, highly vascular substance,

of a reddish-gray color, enveloped in an exceedingly delicate, and apparently structureless membrane, continuous with the alveolo-dental periosteum, and adherent to the walls of the pulp cavity. This is designated by Mr. Thomas Bell "the proper membrane of the pulp," and by Purkinjé and Raschkow, "the preformative membrane;" because, in the formation of the dentine, the deposition of earthy salts, according to these authors, commences in it.

Fig. 16.

Fig. 16. A portion of the body of the pulp, showing another variety in the arrangement of the cells.

The pulp, according to the two last mentioned authors, is composed of minute globules. Schwann describes it as consisting of globular nucleated cells, with vessels and nerves passing between them, the cells having the same radial course as the fibres of the dentine. According to the microscopic observations of Mr. Nasmyth, it is principally composed of minute vesicular cells, varying in size from the ten-thousandth to the one-eighth of an inch in diameter, disposed in concentric layers; these, when macerated, have an irregular reticulated appearance, and are found to be interspersed with granules, the parenchyma being traversed by vessels having a vertical direction. See Figs. 14, 15 and 16, copied from Mr. Nasmyth's Researches on the Development and Structure of the Teeth.

Mr. Tomes describes it as consisting, from its earliest appearance, of a series of nucleated cells, united and supported by plasma; also, prior to the commencement of the formation of the dentine, of delicate areolar tissue, occupied by a thick, clear, homogeneous fluid or plasma. The pulp is liberally supplied with blood-vessels, furnished by the trunk which enters its base. The ramifications of these vessels are distributed throughout its entire substance, forming a capillary net-work which terminates in loops upon its surface.

The distribution of the vessels of the pulp is represented in Fig. 17, copied from the late work of Mr. Nasmyth, and made from an injected preparation of an upper central incisor. The communication of the arteries with the veins by means of a series of looped capillaries, presenting a densely matted appearance

upon the surface, are here beautifully represented. The nerves of the pulp have a very similar arrangement in their distribution, having apparently looped terminations (Fig. 18).

FIG. 17.

FIG. 17. *a* The vessels of the pulp of an upper central incisor injected, as seen under the microscope, very highly magnified; *b* The natural size of the pulp.

Kölliker describes the pulp as consisting of an indistinctly fibrous connective tissue, containing many dispersed, rounded and elongated nuclei; with, occasionally, narrow bundles, some-

what like imperfect fœtal connective tissue, filled with a fluid substance. Immediately beneath the structureless membrane in which these tissues are inclosed, there is a layer composed of many series of cells, cylindrical or pointed at one end, with long and narrow nuclei, arranged perpendicularly to the surface of the pulp, like a cylinder of epithelium. This layer is described as being from two to four one-hundredths of a line in thickness. These, in regular series proceeding internally, become less and less distinct; "but the cells, without losing their radial arrangement, are more intermixed, and pass finally, by shorter and rounder cells, without any sharp line of demarkation, into the vascular tissue of the pulp." His description of the distribution of the vessels and nerves of the pulp is similar to that given by Mr. Nasmyth and Mr. Tomes.

Fig. 18.

Fig. 18. The nerves of the pulp of an upper adult bicuspid, magnified twenty diameters.

The pulp, previous to the formation of the dentine, is inclosed in a sac, consisting of two laminæ, an outer and an inner. The former is described by Mr. Hunter as being soft and spongy, and without vessels; the latter as being extremely vascular and firm. Mr. Thomas Bell, on the other hand, contends that the outer is more tender and full of vessels, while the inner is destitute of them; and this opinion is supported by the microscopic researches of Mr. Nasmyth, who describes the internal lamina of the capsule, previous to its closing and forming a sac, as possessing no vessels, though the injections of Mr. Fox would seem to prove the contrary. But as the author will again have occasion, when he treats of the origin and formation of the teeth, to recur to this subject, he will not enlarge upon it in this place.

THE DENTINE.

The *dentine* (*b* Fig. 9) is a very hard, dense substance, constituting the inner and larger portion of the crown and nearly the whole of the root of the tooth. It consists of earthy salts and animal matter. The former may be removed by the action of acids, leaving the latter entire; by subjecting to a strong heat, the animal portion may be destroyed, leaving the earthy.

Fig. 19.

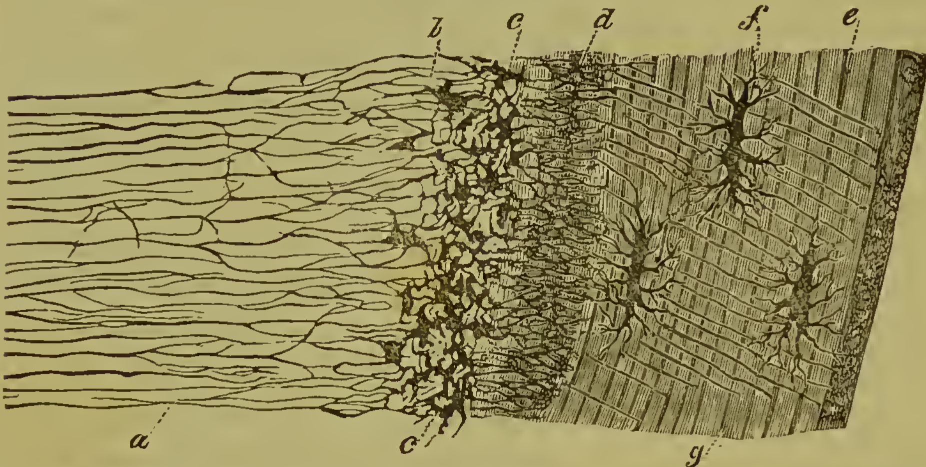


Fig. 19. Dentine and cementum from the root of a human incisor, copied from Kölliker: *a* Dentinal fibres or tubes; *b* Interglobular spaces, having the appearance of the *lacunæ* in bone; *c* Smaller interglobular spaces; *d* Commencement of the cementum, with numerous canals close together; *e* Its *lamellæ*; *f Lacunæ*; *g* Canals.

Dentine is harder than bone or cementum, but less dense than enamel. It is, apparently, disposed in concentric layers, arranged one within the other, parallel to the surface of the tooth—the last internal layer forming the boundary of the pulp-cavity. But in addition to this peculiar structural arrangement, it is, according to the microscopic observations of Purkinjé, Retzius, and Müller, composed of minute tubes or hollow fibres, radiating from the pulp-cavity to the periphery of the tooth, giving off, in their course, numerous branches, as seen in Fig. 19, sometimes terminating in small cells or corpuscles; and an amorphous or structureless intertubular substance. The doctrine of the tubularity of dentine is also sustained by the subsequent researches of Professor Owen, Mr. Tomes, Kölliker and several other microscopists; while on the other hand, Mr. Alexander Nasmyth,

Fig. 20.

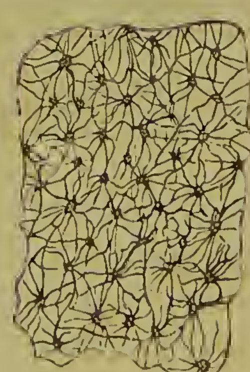


Fig. 20. Transverse section through the dental tubuli of the root of a human tooth, magnified 350 diameters, showing their numerous anastomoses.

equally distinguished as an odontologist, has seemingly demonstrated, by a series of beautiful and highly interesting experiments, that the canaliculi or tubes of these authors, are solid fibres "composed of a series of little masses, succeeding each other in a linear direction, like so many beads collected on a string." See Fig. 21.

This appearance, however, which is not always conspicuous in the human dentine, but is more remarkable in that of monkeys, ought not to mislead the observer; for the tubular character of the so-called "dentine fibres," whether simple or baccated, may be demonstrated in their microscopic sections, which, when dry or properly mounted in Canada Balsam, exhibit the canaliculi *filled with air* as black lines; or when moistened with turpentine or thin balsam allow the fluid to be seen to penetrate into the tubules, expel the air, and render the whole section extremely transparent.

The tubes radiate from the pulp-cavity to the outer surface of the dentine, each tube making, in its course, three principal or primary curves, and presenting, when examined with a high magnifying power, numerous secondary undulations, which are less perceptible at the external extremity of the tubes than at the middle, and still less in the temporary than in the permanent teeth. The diameter of the tubes, from their commencement to the middle of the outer third of their course, is estimated at 1-10,000th of an inch; but from this point their terminal branches rapidly diminish until they become invisible, or are lost in small irregular rounded cells. When examined under a magnifying power of from three to five hundred diameters, they are seen to branch by a dichotomous division and in their whole course to give off numerous lateral branches. The tubes are not mere excavations, but have special parietes; the undulations in them are ascribed to certain periodic movements in the pulp during the formation of the successive layers of dentine, and both Retzius and Müller represent them as containing granular masses of inorganic matter.*

Fig. 21.

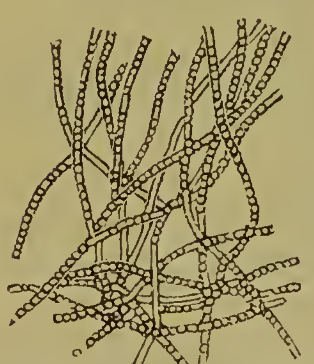


Fig. 21. The nuclei of fibres of dentine, arranged in a linear series, as shown by Mr. Nasmyth.

* Müller's Physiology.

These tubes are represented as piercing every part of the surface of the pulp cavity, being, according to Professor Owen, about the $\frac{1}{1000}$ part of an inch in diameter; they radiate as before stated, from the inner to the peripheral surface of the dentine. "In the lower incisive and canine teeth," says the last mentioned author, "those from the middle of the summit of the pulp cavity, ascend vertically to the enamel covered surface of the dentine at the summit of the crown; the tubes on each side of these gradually incline outward; those which go to the angles of the crown, forming an angle of 45° with the middle vertical tubes; at the sides of the crown the tubes incline still more outward, until in the middle of the fang they become horizontal, and still lower, bend downward."* The vertical tubes are described as being nearly straight, but as they begin to incline downward, they present two, and usually three curves; at the sides of the crown and the upper half of the root they have a short concave bend toward the crown, then a longer curve in the opposite, and, finally, a third curve in the first direction, but having a general concave bend downward. The course of the tubuli may be seen in Fig. 9.

Fig. 22.

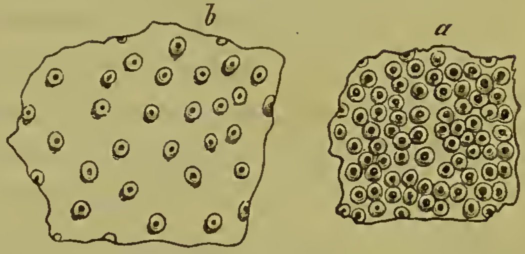


FIG. 22. Transverse section of dentinal canals as they are commonly seen, magnified 450 diameters: *a*, canals very close together; *b*, more dispersed.

The secondary curvatures of the dentinal fibres, or tubes, are very numerous; the last mentioned author says, "Two hundred may be counted in an extent of $\frac{1}{10}$ of an inch; the curvatures observed in these, both primary and secondary are parallel." Professor Retzius describes certain striæ, running parallel with the pulp cavity, "like the annual rings in the trunk of a tree." These circular lines are rarely seen in the dentine of human teeth, though very observable in some animals, especially the elephant, and they are somewhat similar to the contour lines of Professor Owen, proceeding from "a short bend," occasionally observed in the tubes, "along a line parallel with the crown."

The dentinal fibres of the crown, in the teeth of the human subject, give off but few branches, until they arrive nearly at

* Owen's Odontography.

the outer surface of the dentine; the ramifications become more and more numerous towards the extremity of the root, and here, too, the terminal branches anastomose more frequently with each other. In the crown they pass a short distance into the enamel, and terminate in small cavities near the surface; and it is here, or immediately upon the peripheral surface, that dentine is most sensitive. These cavities, called "enamel cells" by Professor C. Johnston of the Baltimore Dental College,* who has the merit of having first pointed out their constancy and probable function, are, doubtless, in connection with the nerves of the pulp, and lodge a portion of neurine.

The researches of Mr. Nasmyth into the structure of dentine, as already intimated, do not accord with those of most other microscopists; he found, when sections made parallel to the fibres were submitted to the action of acid until the earthy salts were all taken up, that the animal residue consisted of solid fibres, presenting an irregular or baccated appearance; being composed of numerous separate compartments or cells, corresponding exactly with the reticulations observed on the surface of the pulp, previous to the deposition of earthy salts, see Fig. 21. The shape and size of these cells, he describes as varying in different animals; in the human tooth as being oval, and as having their long axis corresponding with the course of the fibre, the extremity of each being in apposition with the one adjoining.

The intertubular tissue constitutes a larger portion of the dentine in the root than in the crown of the tooth, and is supposed, by Purkinjé, Retzius, Müller, Kölliker, and other equally distinguished microscopists, to be structureless. Professor Owen and Mr. Nasmyth describe it as cellular. Mr. Tomes says, "it is made up of minute granules, closely united." Professor Kölliker, calls it the matrix of the canals, or tubules, and affirms that it is "homogeneous," "without cells, fibres, or other elements." The "cells" of Owen and Nasmyth are described by Czermák, Salter, and Kölliker under the appellation "dentine globules," of which the limits are usually indistinct, but may be plainly defined by intervening spaces of dentine partly or completely surrounding them. The interglobular spaces, as Mr. Salter has shown, are portions of imperfectly "calcified" dentine; and these, together with the globules, which

* American Journal of Dental Science, July, 1857, p. 348.

are so many centres of dentine "calcification," correspond to a phasis of dentinal development, and, in longitudinal sections, create in a tooth the appearance of stratification indicated by his "contour lines." They are also described as being frequently pierced by the tubuli. The smaller spaces, from their communication with the tubules, have been regarded by some as identical with the *lacunæ* of bone. But Professor Kölliker states that he has rarely "observed actual *lacunæ* in normal dentine," and when present they were always at the boundary of the cement; but "interglobular spaces and dentinal globules" are met with in the interior of the root and on the walls of the pulp cavity, in which latter place they give rise to irregularities which may be seen with the naked eye. Again, he observes, "The interglobular spaces whose presence is normal in developing teeth, contain, during life, not fluid, as might at first be expected, but a soft substance resembling tooth cartilage and possessing a canaliculated structure, like the dentine itself. It is remarkable that this substance offers a greater resistance to long maceration in hydrochloric acid than the matrix of the actually ossified tooth, and, therefore, like the dentinal canals, it may be completely isolated. In sections, this *interglobular* substance usually dries up in such a manner that a cavity is produced, into which air penetrates." It is these, according to this author, which constitute the interglobular spaces, but there are many teeth in which this interglobular substance cannot be detected, where delicate arched outlines of dentinal globules may be observed.

Mr. Tomes describes, under the name of "intermediate substance," a granular layer near the surface of the fang, and of which the uniting medium is the interglobular substance described by Kölliker. The interspaces have the appearance of cells, "granular cells," and he also states, that many of the terminal tubes communicate with these granular cells, as do others, which come from the lacunæ of the cementum. The cells, according to this author, frequently communicate with each other, though there does not appear to be any special provision for such communication.

Most microscopists regard dentine, especially that of human teeth, as destitute of vascular canals, but the author has seen ten or twelve specimens in which their existence was so clearly

demonstrated as to leave no room for doubt. A description and drawing of one of these he published in the second volume of the American Journal of Dental Science. A similar one was shown to him by Dr. Maynard, of Washington City, and he has a section of a molar tooth made by Dr. Blandy, in which several vessels charged with red blood are distinctly seen. Mr. Tomes says he has seen eight or ten sections of vascular dentine, and he has given a drawing of one in which the dentine and cementum are both pierced by vascular canals. The occasional and exceptional appearance of vascular canals in human dentine, does not, however, justify us in regarding that substance as normally vascular.

The delicate sensibility of dentine, especially when in a pathological condition, seems also to favor the opinion that nerve filaments are sent from the pulp to every part of this tissue, traversing, no doubt, the tubuli, which extend from the central chamber to the periphery. Several years ago Dr. Maynard stated to the author and others that, in removing diseased dentine preparatory to filling, especially from the side of a tooth, he found that his patient experienced much less pain when he applied the excavator to the part nearest the root and cut towards the coronal extremity, than when excavating in the opposite direction. Convinced that dentine *must* be supplied with sensitive nerve fibres, he suggested their search to Professor C. Johnston, whose microscopical discoveries demonstrated the fact that nerve filaments constitute an essential element of dentine.

The surface of the dentine of the crown of a tooth, is, as stated by Professor Owen, marked by numerous pits, corresponding with projections of the enamel, and into which these are received.

Every 100 parts of dentine, according to Berzelius, contains,

Phosphate of lime,	62.
Fluate of lime,	2.
Carbonate of lime,	5.5
Phosphate of magnesia,	1.
Soda and muriate of soda,	1.5
Gelatin and water,	28.
	100

Von Bibra makes dried dentine to contain—

	Molar of a woman of 25.	Molar of a man.	Incisor of the same man.
Phosphate of lime, with some fluoride of calcium,	67.54	66.72	
Carbonate of lime,	7.97	3.36	
Phosphate of magnesia,	2.49	1.08	
Salts,	1·00	0.83	
Cartilage,	20.42	27.61	
Fat,	0.58	0.40	
	100.00	100.00	
Organic substance,	21.00	28.01	28.70
Inorganic substance,	79.00	71.99	71.30

The relative proportions, however, of organic and inorganic matter are not always the same. They vary according to the density of the tooth.

The laminated decomposition which occurs in caries of the teeth is owing to the concentric arrangement of the dentine, or, according to Mr. Nasmyth, of the cells.

THE ENAMEL.

The *Enamel* (*c* Fig. 9) covers the crown, and extends to the neck of the tooth, but terminating more remotely from the gum upon the proximal, than upon either of the other surfaces. It is the hardest of all animal substances, is pearly white, or slightly tinged with yellow, according to the texture of the tooth. Like the dentine, it varies in density, being harder in some teeth than others. It is thickest on those parts of the teeth most exposed to friction, as on the eminences of the molars and bicuspids, and the cutting edges of the incisors and points of the cuspids, gradually diminishing to the line of its termination. The structure of the enamel, according to Mr. Nasmyth, is *fibro-cellular*—the fibres radiating from the dentine to the surface of the tooth—an arrangement which gives to this outer investment immense strength and the power of sustaining great pressure. It has a smooth, glossy surface, and on the permanent teeth, is characterized by delicate circular ridges and furrows, which, as stated by Czermák, are never seen on the temporary teeth. It is covered by a delicate calcified membrane, called, by Professor Kölliker,

the *cuticle of the enamel*, and by Huxley, *Nasmyth's membrane*, because Mr. Nasmyth was the discoverer of it. He terms it the "*persistent dental capsule*," and says it is continuous with the structure covering the root. This membrane, according to Professor Kölliker, forms, from the great resistance it offers to chemical reagents, a peculiarly appropriate defence for the crown of the tooth.

FIG. 23.

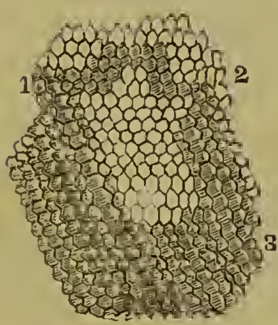


FIG. 23. The hexagonal terminations of the fibres of a portion of the surface of the enamel, highly magnified. At 1, 2, 3, the crooked crevices, between the hexagonal fibres, are more strongly marked.

FIG. 24.

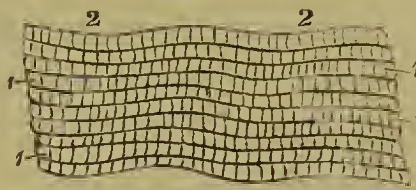


FIG. 24. A side view of the enamel fibres magnified 350 diameters; 1 1, The enamel fibres; 2 2, Transverse striæ upon them.

The enamel is composed of prisms or fibres, for the most part of an hexagonal or pentagonal shape, arranged side by side, with one extremity resting upon the dentine, and the other upon *Nasmyth's membrane*, which, properly, constitutes the peripheral surface of the crown of the tooth. The fibres are marked, as seen in Fig. 24, by transverse striæ, showing them to be, as is remarked by Professor Owen, "essentially the contents of extremely delicate membranous tubes, originally subdivided into minute depressed compartments or cells," and which, the author is inclined to believe, constitutes the animal framework of the tissue, and probably the bond of union between the fibres. The existence, however, of such uniting medium is not universally recognized by physiologists.

The prisms of the enamel have a wavy course, like the dentinal fibres of the crown of the tooth, the curvatures, for the most part, being parallel to each other, and more marked near the external than the internal surface. The curves, however, in the enamel fibres are shorter and more strongly marked than in the dentinal fibres. The prisms usually extend through the entire thickness of the enamel, but sometimes they fall short, and at other times they diverge near the external surface. When either of these happens, "shorter complemental fibres fill up the interspace." And this interpolation of enamel prisms in the

outer portion of their substance is inevitable, for as the free surface of enamel is more extensive than the inner or dentinal surface, and as the prisms are everywhere of equal diameter, the prisms springing from the dentine cups, even if they all reached the coronal surface, would not suffice to make the outer layer complete.

Fig. 25.

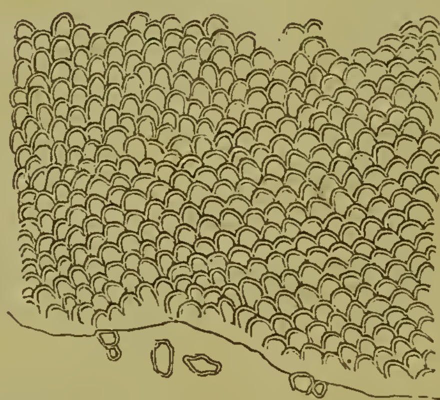


Fig. 25. The enamel seen in a section not quite at right angles with the course of the prisms.

But in addition to the peculiar structural arrangement just described, the enamel, according to Mr. Nasmyth, is cellular. Each cell he represents (Fig. 25) as having a semicircular form, the convexity of the semicircle looking upwards towards the free external portion of the tooth. This explanation of a familiar appearance we take to be erroneous.

Thus, by the beautiful and peculiar structural arrangement of the enamel prisms, a capability of resisting mechanical force is given, which a simply fibrous structure would be wholly inadequate to supply.

The enamel, like the dentine, consists of organic and inorganic matter—the former being less than the latter. Its chemical composition, according to Berzelius, is,

Phosphate of lime, . . .	85.3
Fluate of lime, ...	3.2
Carbonate of lime, . . .	8.0
Phosphate of magnesia, . .	1.5
Soda and muriate of soda, . .	1.0
Animal matter and water, . .	1.0
	100

Von Bibra makes it to consist of

	From a molar of a woman twenty-five years of age.	From a molar of an adult man.
Phosphate of lime, with some fluoride of calcium,	81.63	89.82
Carbonate of lime,	8.88	4.37
Phosphate of Magnesia,	2.55	1.34
Salts,	0.97	0.88
Cartilage,	5.97	3.39
Fat,	a trace	0.20
	100.00	100.00
Organic matters,	5.97	3.59
Inorganic matters,	94·03	96·41

These proportions, as in the case of dentine, are not always the same. They vary in the enamel of the teeth of different individuals.

THE CEMENTUM.

The *Cementum*, or *Crusta Petrosa*, (*d*, Fig. 9,) covers the root, commencing where the enamel terminates, and gradually increases in thickness to its apex. It has also been traced over the enamel, and Mr. Nasmyth is of the opinion that it always invests the crowns of the teeth, but the author has never been able to detect it except upon the roots. If, therefore, it is formed upon the crown, it is evidently soon worn off by the friction of mastication. The case mentioned by Purkinjé and Frankel, in which they discovered it upon the enamel of the teeth of an old man, is an exception to the general rule.

In many animals, however, it covers the crowns of the teeth, and sometimes unites vertical plates of enamel and dentine into a solid tooth, as in the case of the molar teeth of the elephant.

Cementum corresponds in structure with osseous tissue, being furnished with lacunæ, and, when of sufficient thickness, is traversed by vessels capable of conveying red blood. Mr. Tomes says he has several specimens of healthy human teeth, in the cementum of which vascular canals exist; and in one, where two canals enter from the surface, they anastomose, and give off three branches.

The cementum, like dentine, is arranged in concentric layers. It is also cellular, according to Mr. Tomes, the cells (lacunæ) being

scattered through it "with some degree of regularity, generally, though not always, following a course as though placed between concentric laminæ." From the cells tubes are given off which anastomose with each other and with those from contiguous cells. "By this arrangement," says the author last named, "a net-work of cells and tubes, permeable by fluids, is carried through the whole mass." He also states that "the majority of the radiating tubes pass, either toward the surface of the tooth, or, when such exists, toward the surface of a canal for a blood-vessel. Many branches also go toward the dentine, and anastomose with the terminal branches of the dentinal tubes, while a few follow the course of the length of the tooth, anastomosing freely with tubes pursuing a like direction. Frequently, however, a cell with its tubuli resembles a tuft of moss, the mass of tubes taking the same direction, and that toward a surface upon which blood vessels pass." The cells of the cement are usually oblong, as may be seen in Fig. 19, though sometimes they are circular and occasionally fusiform. They are as variable in size as in shape. The average of their long diameter is stated by Professor Owen to be about $\frac{1}{2000}$th of an inch.

The cementum is much thicker on the permanent teeth than on the temporary, and it is thicker on the teeth of old persons than on those of young. In the former case it is often reflected into the pulp cavity at the extremity of the root, sometimes completely obliterating it at this point.

Cementum is composed, according to Von Bibra, of

	In man.	In the ox.
Organic matters,	29.42	32.24
Inorganic matters,	70.58	67.76
	100.00	100.00

In the latter he found:

Phosphate of lime and fluoride of calcium,	58.73
Carbonate of lime,	7.22
Phosphate of magnesia,	0.99
Salts,	0.82
Cartilage,	31.31
Fat,	0.93
	100.00

Thus it is seen, that the cementum contains a larger proportion of organic matters than dentine, and it is endowed with greater sensibility. This circumstance will account for the fact that, when the neck of a tooth becomes exposed by the recession of the gums, the slightest touch is often productive of severe pain. The cementum is necessary to the preservation of the connection between the teeth and the general system, for if the dentine of the roots were not covered by it, these organs would act as irritants, and nature would at once make an effort to expel them from the body. In this, therefore, as in every thing else connected with the animal economy, wisdom of design is displayed.

DESCRIPTION OF TEETH BELONGING TO EACH CLASS.

Each tooth, as has already been remarked, has a body or crown, a neck, and a root or fang. In describing these several parts, I shall begin with

THE INCISORS.

The *Incisors* (four to each jaw, Fig. 26, *a a*, *a a*,) occupy the anterior central part of each maxillary arch. The body of each

Fig. 26.

Fig. 26. *a a*, *a a* Front view of the incisors; *b b*, *b b* Palatine or lingual view; *c c*, *c c* Side or lateral view.

is wedge shape—the anterior or labial surface is convex and

smooth; the posterior or palatine is concave, and presents a tubercle near the neck; the palatine and labial surfaces come together, and form a cutting edge. In a front view, the edge is, generally, the widest part; it diminishes toward the neck, and continues narrowing to the extremity of the root.

The crown of an incisor has four surfaces; two *approximal*, one *labial*, and one *palatine* or *lingual*—the term *palatine* being applied to an upper, and *lingual* to a lower incisor. It also has four angles; namely, a *right* and a *left labio-approximal*, and a *right* and a *left palato-approximal*, or *lingua-approximal.*

The two large incisors which are situated one on each side of the median line, are termed the central; the other two, the lateral incisors, or laterals. The crowns of the upper central incisors are about four lines in breadth, and the laterals three. In the lower jaw, the crowns of the central incisors are only about two lines and a half in width, while the laterals are usually a little wider. But the width of the crowns of all the incisors varies in different individuals.

The length of a superior central incisor is usually about one inch, and that of a lateral is half of a line less. In the lower jaw the central incisors are only about ten lines in length; the laterals are about one line and a half longer.

The length of the crown of an incisor is exceedingly variable. That of an upper central varies from four and a half to six lines; and there is the same want of uniformity in this respect with the crowns of all the incisors.

The roots are all single, of a conical form, flattened laterally, and slightly furrowed longitudinally. The enamel is thicker before than behind, and thinnest at the sides.

The function of this class of teeth, as their name imports, is to cut the food, and for the performance of this office they are admirably fitted by their shape. As age advances, their edges often become blunted; but the rapidity with which they are worn away, depends altogether upon the manner in which those of the upper and lower jaw come together.

THE CUSPIDATI, OR CUSPIDS.

The *Cuspidati*, *Canini*, or *Cuspids* (Fig. 27), are situated next to the incisors, two to each jaw, one on either side. They

somewhat resemble the upper central incisors with their angles rounded. Their crowns are conical, very convex externally; and their palatine surface more uneven, and having a larger tubercle than the incisors. Their roots are also larger, and of all the teeth the longest; like the incisors, they are also single, but have a groove extending from the neck to the extremity, showing a step towards the formation of two roots. A cuspid, like an incisor, has four surfaces, and four angles, designated by the names already given.

FIG. 27.

FIG. 27. *a a* Front view of the cuspids; *b b* Palatine and lingual view; *c c* Side view.

The breadth of the crown of an upper cuspid is about four lines, that of a lower is about three and a half; but as in the case of the incisors, the width of the crowns of these teeth is variable. The length of a cuspid is greater than that of any other tooth in the dental series—it being about thirteen lines. The breadth of the neck of one of these teeth is about one-third greater in front than behind, and from before backwards it measures about four lines.

The upper cuspids are called eye-teeth; the lower are termed stomach teeth.

These teeth are for tearing the food, and in some of the carnivorous animals, where they are very large, they not only rend but also hold their prey.

The incisors and cuspids together are termed the *oral* teeth.

THE BICUSPIDS.

The *Bicuspids*, (Fig. 28,) four to each jaw, and two on either side, are next in order to the cuspids. They are so called from their having two distinct prominences or cusps on their grinding surfaces. They are also named the small molars. They are thicker from their buccal to their palatine surface than either of the incisors, and are flatter on their sides. The grinding surface of each is surmounted by two conical tubercles, separated by a groove running in the direction of the alveolar arch; the outer

is larger and more prominent than the inner. In the lower jaw these tubercles are smaller than in the upper, and the inner is sometimes wholly wanting.

A bicuspid has five surfaces; namely, two *approximal*, one *anterior* and one *posterior;* one *buccal;* one *palatine* or *lingual* surface, as the tooth may be in the upper or lower jaw, and one *grinding* surface. It has also four angles; one *anterior*, and one *posterior palato-approximal*, and one *anterior* and one *posterior bucco-approximal* angle.

Fig. 28.

Fig. 28. *a a*, *a a* Buccal view of the bicuspids; *b b*, *b b* Palatine and lingual view; *c c*, *c c* Side view.

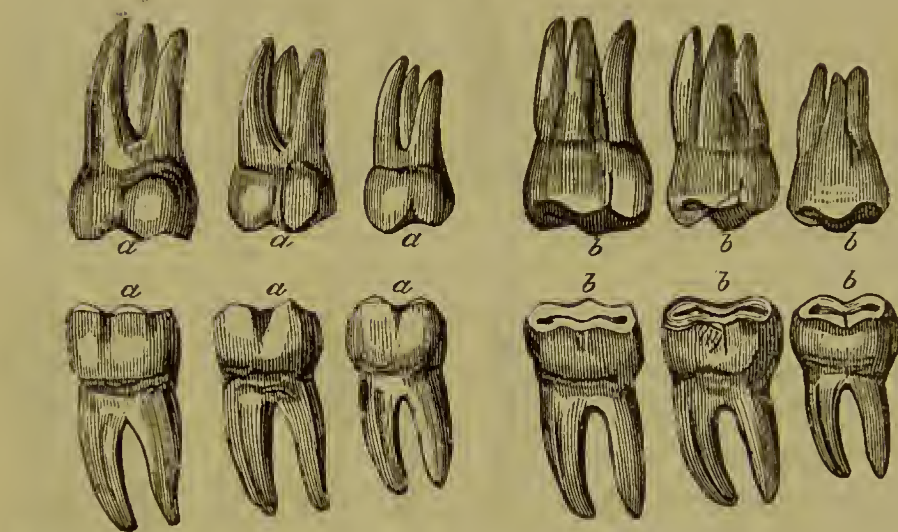
The size of these teeth, like that of the incisors and cuspids, is variable. The buccal surface of the crown of a superior biscuspid of ordinary size at its broadest part, is about three lines in breadth, while the anterior and posterior approximal surfaces are about four lines. The palatine is not quite as wide as the buccal surface. All the diameters of the crown of a lower bicuspid are usually a little less than those of an upper. The entire length of a bicuspid is ordinarily about eleven lines.

The roots of the bicuspids are, generally, simple; though the groove is deeper than in the cuspids, and not unfrequently terminates in two roots, which have each an opening for the vessels and nerves to enter. The inner root, however, is always smaller than the outer. Two fanged bicuspids are more frequently met with in negroes than in whites; and the double fang is common, if not constant, in the aboriginal Australians.

THE MOLARS.

The *Molars* (Fig. 29) occupy the posterior part of the alveolar

FIG. 29.



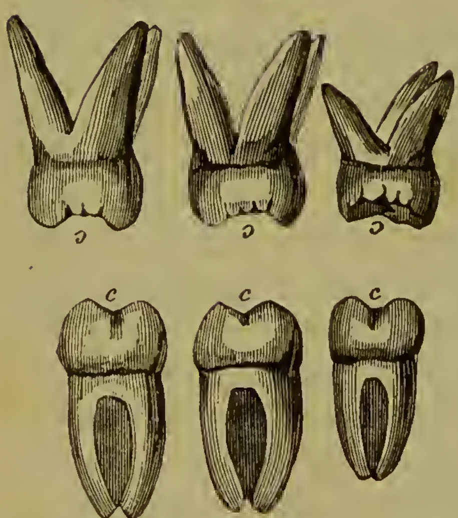


FIG. 29. *a a a*, *a a a* Outer view of the molars; *b b b*, *b b b* Inner view; *c c c*, *c c c* Side view.

arch, and are six in each jaw, three on either side. They are distinguished by their greater size, the first and second being the largest; the grinding surfaces have the enamel thicker, and are surmounted by four or five tubercles or cusps, with as many corresponding depressions, arranged in such a manner that the tubercles of the upper jaw are adapted to the depressions of the lower, and vice versa. A molar, like a bicuspid, has also five surfaces and five angles, designated by the names already given.

The upper molars have three roots, sometimes four, and as many as five are occasionally seen; of these roots two are situated externally, almost parallel with each other, and perpendicular; the third root forms an acute angle, and looks toward the roof of the mouth. The former are called the *buccal* roots, and the latter the *palatine*. The roots of the two first superior molars correspond with the floor of the maxillary sinus, and some-

times protrude into this cavity, their divergence securing them more firmly in their sockets. The lower molars have but two roots, the one anterior, the other posterior; they are nearly vertical, parallel with each other and much flattened laterally.

The last molar, called the *dens sapientiæ*, or wisdom tooth, is both shorter and smaller than the others, the roots of the upper wisdom tooth are, occasionally, united so as to form but one; while the last molar of the lower jaw is generally single and of a conical form.

The roots of the molar teeth, both of the upper and lower jaw, after diverging, sometimes approach each other, embracing the intervening bony partition in such a manner as to constitute an obstacle to their extraction.

The bucco-palatine diameter of the crown of an upper molar is usually a little less than the antero-posterior. In the lower jaw, the bucco-lingual and antero-posterior diameters are generally about the same.

The crown of the first molar is generally larger than the second, and the second larger than the third or wisdom tooth; and the crown of the last named tooth is always smaller in the upper than in the lower jaw.

The length of a molar tooth varies from eight to twelve and a half or thirteen lines.

The molars and bicuspids together constitute what are termed the buccal teeth.

The use of the molars, as their name signifies, is to triturate or grind the food during mastication, and for this purpose they are admirably adapted by their mechanical arrangement.

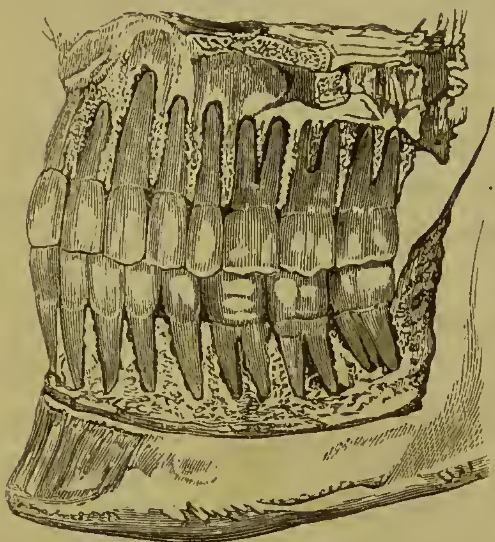
ARTICULATION OF THE TEETH.

The manner in which the teeth are confined in their sockets, is by a union called *gomphosis*, from the resemblance of this kind of articulation to the way in which a nail is received into a board. Those teeth having but one root, and those with two perpendicular roots depend greatly for the strength of their articulation on their nice adaptation to their sockets.

Those having three or four roots have their firmness much increased by their divergence.

But there are other bonds of union; by the periosteum lining the alveolar cavities, and investing the roots of the teeth; also by the blood vessels entering the apices of the roots; and finally, by the gums, which will be noticed in another place.

FIG. 30.



DIFFERENCES BETWEEN THE TEMPORARY AND PERMANENT TEETH.

The temporary and permanent teeth differ in several respects, and on this point I will give Mr. Bell's observations:

"The temporary teeth are, generally speaking, much smaller than the permanent; of a less firm and solid texture, and their characteristic forms and prominences much less strongly marked. The incisors and cuspids of the lower jaw are of the same general form as in the adult, though much smaller; the edges are more rounded, and they are not much more than half the length of the latter. The molars of the child, on the contrary, are considerably larger than the bicuspids which succeed them, and resemble very nearly the permanent molars.

"The roots of the tooth, in the molars of the child, are similar in number to those of the adult molars, but they are flatter and thinner in proportion, more hollowed on their inner surfaces, and diverge from the neck at a more abrupt angle, forming a sort of arch."

RELATIONS OF THE TEETH OF THE UPPER TO THOSE OF THE LOWER JAW, WHEN THE MOUTH IS CLOSED.

The crowns of the teeth of the upper jaw generally describe a rather larger arch than those of the lower. The upper incisors and cuspids usually shut over and in front of the lower; but sometimes they fall plumb upon them, and at other times, though rarely, they come on the inside. The external tubercles

or cusps of the superior bicuspids and molars, generally strike on the outside of those of the corresponding inferior teeth. By this beautiful adaptation of the tubercles of the teeth of one jaw to the depressions of those of the other, every part of the grinding surface of these organs is brought into immediate contact in the act of mastication; which operation of the teeth, in consequence, is rendered more perfect than it would be if the organs came together in any other manner.

The incisors and cuspids of the upper jaw are broader than the corresponding teeth in the lower; in consequence of this difference in the lateral diameter of the teeth of the two jaws, the central incisors of the upper cover the centrals and about half of the laterals in the lower, while the superior laterals cover the remaining half of the inferior and the anterior half of the adjoining cuspids. Continuing this peculiar relationship, the upper cuspids close over the remaining half of the lower and the anterior half of the first inferior bicuspids, while the first superior bicuspids cover the remaining half of the first inferior and the anterior half of the second. In like manner, the second bicuspids of the upper jaw close over the posterior half of the second and the anterior third of the first molars in the lower. The first superior molars cover the remaining two-thirds of the first inferior and the anterior third of the second; while the two-thirds of this last and anterior third of the lower dentes sapientiæ, are covered by the second upper molars. The dentes sapientiæ of the superior maxilla, being usually about one-third less in their antero-posterior diameter, cover the remaining two-thirds of the corresponding teeth in the lower jaw. (See Fig. 30.)

Thus, from this arrangement of the teeth, it will be seen, that when the mouth is closed, each tooth is opposed to two; and hence, in biting hard substances, and in mastication, by extending this mutual aid, a power of resistance is given to these organs which they would not otherwise possess. Moreover, as a late English writer, Mr. Tomes, very justly observes, if one, or even two adjoining teeth should be lost, the corresponding teeth in the other jaw would, to some extent, still act against the contiguous organs; and thus, in some degree, counteract a process, first noticed by that eminent dentist, Dr. L. Koecker, which nature sometimes sets up for the expulsion of such teeth as have lost their antagonists.

The order and time in which both temporary and permanent teeth appear, will be noticed in the chapters on First and Second Dentition.

ACTIVE ORGANS OF MASTICATION.

The active organs of mastication consist of the muscles attached, principally, to the upper and lower maxillary bones, the temporals, malar bones and the sphenoid; by these, the various motions of mastication are effected.

They are the temporalis, the masseter, pterygoideus externus, and the pterygoideus internus.

The *Temporal Muscle* (Fig. 31) is seen on the side of the

Fig. 31.

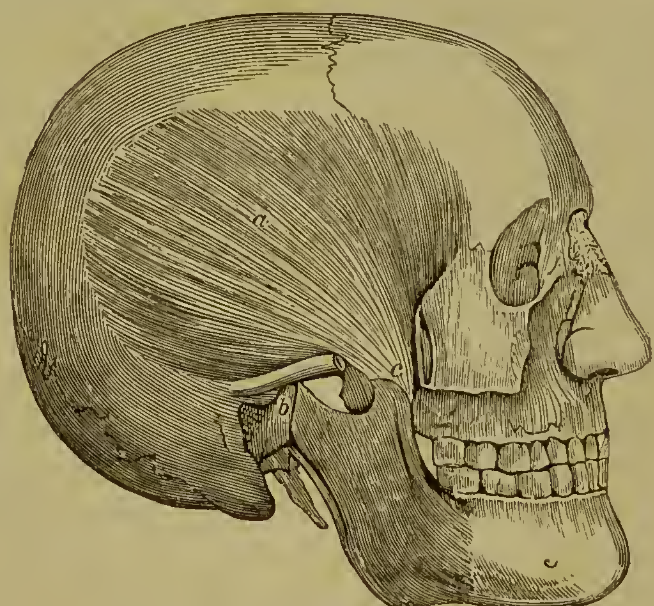


Fig. 31. *a* Side view of the temporal muscle, exposed by the removal of the temporal fascia; *b* External lateral ligament of the lower jaw; *c* Insertion of temporal muscle into coronoid process of lower jaw.

head; it has its origin from the semicircular ridge commencing at the external angular process of the os-frontis, and extending along this and the parietal bones—also from the surfaces below this ridge formed by the frontal and squamous portion of the temporal and sphenoid bones; likewise from the under surface of the temporal aponeurosis, a strong fascia covering this muscle; and its fibres are inserted, after they have converged and passed under the zygoma, into the coronoid process of the lower jaw, surrounding it on every side by a dense strong tendon.

The office of this muscle is to bring the two jaws together, as in the cutting and rending of the food.

The *Masseter Muscle* (Fig. 32) is seen at the side and back

FIG. 32.

FIG. 32. Side view of the muscles of external ear, cranium and face: *a* Occipito-frontalis; *b* Orbicularis palpebrarum; *c* Pyramidalis nasi; *d* Compressor nasi; *e* and *f* Levator labii superioris alæque nasi; *g* Zygomaticus minor; *h* Zygomaticus major; *i* Masseter Muscle; *j* Buccinator muscle; *k* Depressor anguli oris; *l* Depressor labii inferioris; *m* Orbicularis oris; *n* Auterior auris; *o* Superior auris; *p* Posterior auris; *q* External lateràl ligament; *r* Deep-seated portion of masseter muscle; *s* Temporal fascia.

part of the face in front of the meatus externus, and lies directly under the skin. It arises by two portions: the one anterior and tendinous, from the superior maxilla where it joins the malar bone; the other portion, mostly fleshy, from the inferior edge of the malar bone and the zygomatic arch as far back as the glenoid cavity; and is inserted, tendinous and fleshy, into the external side of the ramus of the jaw and its angle as far up as the coronoid process.

The use of this muscle, when both portions act together, is to close the jaws; if the anterior acts alone, the jaw is brought forward, if the posterior, it is drawn backward.

Pterygoideus Externus (*a* and *b* Fig. 33) arises from the outer surface of the external plate of the pterygoid process of the sphenoid bone, from the tuberosity of the superior maxilla, and from the ridge on the sphenoid bone separating the zygomatic from the pterygoid fossa; and is inserted into the inner side of the neck of the lower jaw, and capsular ligament of the articulation.

Pterygoideus Internus arises, tendinous and fleshy, from the inner surface of the pterygoid plate, fills up the greater part of the pterygoid fossa, and is inserted, tendinous and fleshy, into

FIG. 33.

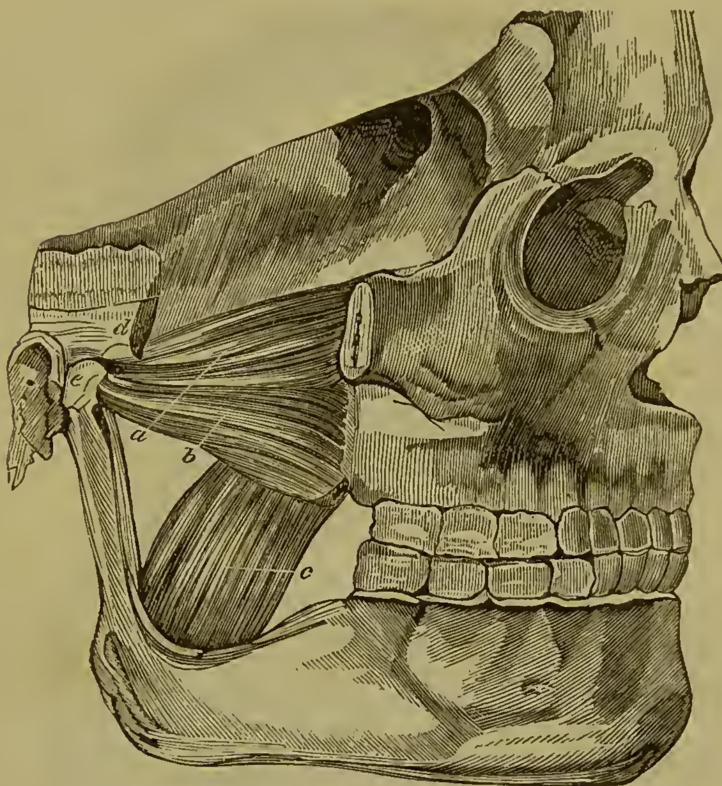


FIG. 33. *a* and *b* Superior and inferior portions of the pterygoideus externus; *c* Pterygoideus internus; *d* Root of zygomatic process; *e* Condyle.
The ramus is cut away to show the internal pterygoid muscle.

the inner face of the angle of the inferior maxilla and the rough surface above the angle.

These two muscles are the great agents in producing the grinding motion of the jaws, and this they do by acting alternately.

The external one is triangular, having its base at the pterygoid process and running outwards and backwards to the neck of the condyle. When the pair act together, the lower jaw is thrown forwards. The internal is strong and thick, placed on the inside of the ramus of the jaw, and running downwards and backwards to the angle. When the pair act together, the jaw is drawn forward and closed.

CHAPTER THIRD.

ORGANS OF INSALIVATION.

THE *Organs of Insalivation* are the salivary glands, six in number, three on each side of the face, named the *Parotid*, *Submaxillary* and *Sublingual.*

These glands are the prime organs in furnishing the salivary fluids to the mouth during the process of mastication.

FIG. 34.

FIG. 34. View of the salivary glands; *a* Parotid gland; *b* Submaxillary gland; *c* Sublingual glands; *d* Duct of Steno; *e* Duct of Wharton, or submaxillary duct.

The *Parotid Gland*, (*a* Fig. 34,) so called from its situation near the ear, is the largest of the salivary glands. Its form is very irregular; it fills the space lying between the ramus of the inferior maxilla and mastoid process of the temporal bone, as far back as, and even behind, the styloid process of the same bone. Its extent of surface is from the zygoma above to the angle of the lower jaw below, and from the mastoid process and meatus externus behind to the masseter muscle in front, overlapping its posterior portion.

This gland is one of the conglomerate order, and consists of

numerous small granular bodies connected together by cellular tissue; each of which may be considered a small gland in miniature, as each is supplied with an artery, vein and secretory duct.

The gland thus formed, presents on its external surface a pale, flat, and somewhat convex appearance.

It is covered by a dense, strong fascia extending from the neck, and attached to the meatus externus of the ear; it sends countless processes into every part of the gland, separating its lobules and conducting the vessels through its substance.

The use of this gland is to secrete or separate from the blood the greater part of the saliva furnished to the mouth. As the parotid is, however, on the outside, and at some little distance from the mouth, it is furnished with a duct to convey its fluid into this cavity; this duct is called the duct of *Steno*, or the parotid duct. It is formed of the excretory ducts of all the granules composing this gland, which, successively uniting together, at last form one common duct.

The duct of Steno commences at the anterior part of the gland and passes over the masseter muscle, on a line drawn from the lobe of the ear to the middle part of the upper lip; then passes through a quantity of soft adipose matter, and finally, enters the mouth by passing through the buccinator muscle and mucous membrane opposite the second molar of the upper jaw.

It is a fact established by experiment, that the two parotid glands do not usually pour out their secretion simultaneously, but that gland alone furnishes its fluid, which is on the side on which the bolus of food is being ground by the molars.

The *Submaxillary* (*b* Fig. 34) is the next in size of the salivary glands. It is situated under and along the inferior edge of the body of the lower jaw, and is separated from the parotid simply by a process of fascia.

It is of oval form, pale color, and, like the parotid, consists in its structure of small granulations, held together by cellular tissue; and each having a small excretory duct, which, successively uniting with one another, finally form one common duct. This, the duct of Wharton, passes above the mylo-hyoid muscle,

and running forward and inward enters the mouth below the tip of the tongue at a papilla seen on either side of the frænum linguæ.

The use of this gland is the same as the parotid, to secrete a fluid constituent of the saliva, and its duct is the route by which it is conducted into the mouth.

The *Sublingual Glands* (*c* Fig. 34) are the last in order of the salivary glands, and the smallest in size.

They are situated beneath the anterior and lateral parts of the tongue, are covered by the mucous membrane, and rest upon the mylo-hyoid muscle.

They, like the two glands just described, consist of a granular structure with excretory ducts; which, however, do not unite into one common duct, but enter the cavity of the mouth by many ducts, whose openings are through the mucous membrane between the tongue and the inferior cuspid and bicuspid teeth.

Their office is the same as the parotid and submaxillary.

FIG. 35.

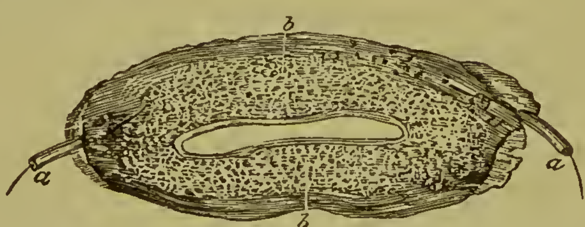


FIG. 35 A view of inner side of the lips, with the mucous membrane removed so as to show the labial and buccal glands; *a a* Ducts of Steno; *b b* Labial glands.

The *Mucous Glands*, (Fig. 35.) Besides the glands furnishing the saliva, there is another series of much smaller size, called the *mucous glands*. They are simply the little crypts, follicles, or depressions everywhere found in the mucous membrane of the mouth, and named, according to their situation, the glandulæ labiales, glandulæ buccales, etc. The lips, cheeks and palate are also furnished with glands, about the size of a small pea, which present the true salivary structure.

The use of these glands is to furnish the mucus of the mouth, which they pour into this cavity by single orifices, opening every where on its surface.

CHAPTER FOURTH.

ORGANS OF DEGLUTITION.

The *Organs of Deglutition* succeed next in the physiological order, and are the last in the series belonging to the mouth as concerned in the primary stages of digestion.

They consist of,

1. The Pharynx,
2. The Soft Palate, and
3. The Tongue.

This class of organs, as the term implies, is concerned in swallowing, or conveying the food, after it has undergone the process of mastication, and become properly mixed with the salivary fluids, into the œsophagus, to be thence conducted into the stomach for the after stages of digestion.

The *Pharynx* (Fig. 36) is a large musculo-membranous bag, open in front, and situated behind the mouth, the nares, and soft palate. It is connected above by a strong aponeurosis to the basilar process of the occipital bone, and extends below as far as the fourth and fifth cervical vertebræ; behind, it is attached to the bodies of the vertebræ, and, laterally, it is connected with the expanded cornua of the hyoid bone.

By these several attachments, it forms a constant and unoccupied cavity, in which may be seen seven openings leading from it, in various directions. The two posterior nares are at the upper and nasal portion; on each side of these, and at the back part of the inferior spongy bones are the two Eustachian tubes leading to the ear. In front and below the velum, is the opening into the mouth, and still lower down the opening of the glottis and the commencement of the œsophagus.

The *Muscles of the Pharynx* are four in number, namely:

1. The Superior—constrictor pharyngis superior.

2. The Middle—constrictor pharyngis medius.
3. The Inferior—constrictor pharyngis inferior.
4. Stylo pharyngeus.

The constrictors are seen on the posterior part of the pharynx after removing the cervical vertebræ, and present very much the appearance of one continued sheet of muscle.

FIG. 36.

FIG. 37.

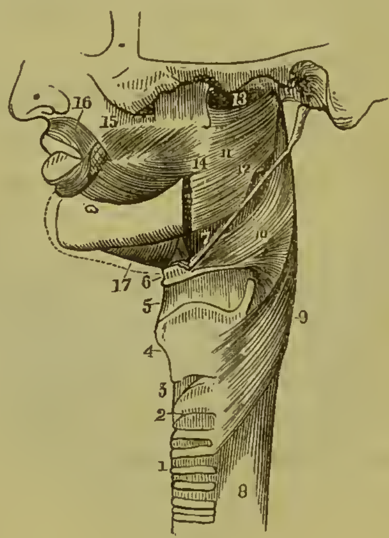


FIG. 36. Posterior view of the muscles of the pharynx. 1, vertical section, transversely of the base of the skull, just in advance of the cervical vertebræ; 2. 3, posterior border and angle of the lower jaw; 4, internal pterygoid muscle; 5, styloid process giving attachment to 6, the stylo-pharyngeal muscle; 7, larynx; 8, inferior constrictor of the pharynx; 9, middle constrictor; 10, superior constrictor.

FIG. 37. Side view of the muscles of the pharynx. 1, trachea; 2, cricoid cartilage; 3, vocal membrane; 6, hyoid bone; 7, stylo-hyoid ligament; 8. œsophagus; 9, inferior constrictor of the pharynx; 10, middle constrictor; 11, superior constrictor; 12, portion of the stylo-pharyngeal muscle observed passing into the interval between the superior and middle coustrictors; 13, upper extremity of the pharynx; 14, pterygo-maxillary ligament; 15, buccinator muscle; 16, oral orbicular muscle; 17, mylo-hyoid muscle.

The *Superior Constrictor* (10 Fig. 36) arises from the cunei-form process of the occipital bone, from the lower part of the inter-nal pterygoid plate of the sphenoid bone, from the pterygo-maxillary ligament, and from the posterior third of the mylo-hyoid ridge of the lower jaw, near the root of the last molar tooth. It is inserted with its fellow into the middle tendinous line at the back of the pharynx.

The *Middle Constrictor* of the pharynx (9 Fig. 36) arises from the appendix and both cornua of the os-hyoides, and from the thyro-hyoid ligament; its fibres ascend, run transversely and descend, giving a triangular appearance; the upper ones overlap the superior constrictor, while the lower are beneath the inferior;

the whole pass back to be inserted into the middle tendinous line of the pharynx.

The *Inferior Constrictor* of the pharynx (8 Fig. 36) arises from the side of the thyroid cartilage and its inferior cornu, and from the side of the cricoid cartilage, and is inserted with its fellow into the middle line on the back of the pharynx.

This is the largest of the constrictor muscles, and overlaps the middle constrictor.

The action of all these muscles is, to compel the food to take the downward direction into the œsophagus. The pharynx is lined with mucous membrane.

The *Stylo Pharyngeus* arises from the root of the styloid process, and is inserted into the side of the pharynx and corner of the os-hyoides and thyroid cartilage. It is a long and narrow muscle, and passes to the pharynx between the upper and middle constrictors. Its use is to elevate and draw forward the pharynx, to receive the food from the mouth, also to raise the larynx.

THE SOFT PALATE.

The *Soft Palate* is a movable curtain, composed of mucous membrane, enclosing several muscles. It is situated at the back part of the mouth between this cavity and the pharynx, is connected above to the posterior edge of the hard palate, and laterally to the side of the tongue and pharynx.

By this arrangement, the soft palate has the appearance of a lunated or arched veil between the cavity of the mouth and the pharynx.

In the centre of this arch an oblong body is suspended, called the uvula, which divides the soft palate into lateral half arches, that pass on either side from the uvula to the root of the tongue.

There is also seen passing from the uvula on each side to the pharynx, two other arches, which, from being behind the first, are called the posterior arches, or pillars.

Between the anterior and posterior pillars, on either side, is a triangular interval containing the tonsil glands.

The *fauces* are the straits or passage leading from the mouth

to the pharynx; and the space included between the soft palate *above*, the half arches and tonsils on *either side*, and the root of the tongue *below*, is called the isthmus of the fauces.

The muscles of the palate are four pairs, and one single one, namely:

1. The Levator Palati.
2. The Tensor or Circumflexus Palati.
3. Constrictor Isthmi-Faucium, or Palato-Glossus.
4. Palato-Pharyngeus.
5. Azygos-Uvulæ is the single muscle.

The *Levator Palati* (*b b* Fig. 38) arises from the point of the petrous portion of the temporal bone and adjoining portion of the Eustachian tube, descends and is inserted into the soft palate. Its use is to raise the palate.

Fig. 38.

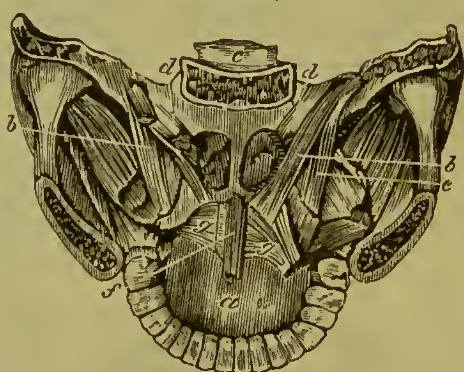


Fig. 38. Posterior view of the muscle of the soft palate: *a* Roof of the mouth or hard palate; *b b* Levator palati; *c* Basilar portion of sphenoid bone; *d d* Eustachian tubes; *e* Tensor or circumflexus palati; *f* Azygos-uvulæ; *g g* Palato-pharyngeus—posterior half arch.

The *Tensor*, or *Circumflexus Palati*, arises from the base of the pterygoid process of the sphenoid bone, and from the Eustachian tube, descends in contact with the internal pterygoid muscle to the hamulus, round which it winds, and is inserted into the soft palate where it expands and joins its fellow. Its office is to spread the palate.

Constrictor Isthmi-Faucium occupies the anterior lateral half arches of the palate; it arises from the side of the tongue near its root, and is inserted into the velum near the uvula.

It draws the velum down and closes the opening of the fauces.

Palato-Pharyngeus occupies the posterior lateral half arches of the palate, and extends from the soft palate behind, near the uvula, as its origin, and is inserted into the pharynx between the middle and lower constrictors and into the thyroid cartilage.

Its use is to draw down the velum and raise the pharynx.

Azygos Uvulæ arises from the posterior spine of the palate bones at the termination of the palate suture, runs along the central line of the soft palate, and ends in the point of the uvula. It raises and shortens the uvula.

It is thus seen that the various muscles of the soft palate are all concerned, more or less, in conducting the food into the pharyngeal cavity. The elevators raise the palate, and at the same time protect the posterior nares from regurgitation of the food; while the tensor puts it on the stretch, and after having passed the velum, the constrictor isthmi-faucium and palato-pharyngeus draw the palate down, and thus close the opening into the mouth; after which the food, as already mentioned, is grasped by the constrictor muscles of the pharynx, and conveyed into the œsophagus.

The *Tonsils* are two bodies, each about the size of an almond, seen at the root of the tongue on its sides, occupying the cavity between the anterior and posterior half arches. They consist of a group of compound follicular glands, forming somewhat oval bodies, whose enlargement constitutes an obstacle to deglutition, and by their locality near the mouths of the Eustachian tubes, frequently cause obstruction and deafness.

FIG. 39.

FIG. 39. A front view of the upper surface of the tongue and palatine arch; *a a* Posterior lateral half arches, containing the palato-pharyngei muscles and the tonsils; *b* Epiglottis cartilage; *c c* Ligament and mucous membrane, extending from root of tongue to base of epiglottis cartilage; *d* Foramen cæcum or central lenticular papilla; *e* Lenticular papillæ; *f* Filiform papillæ; *g* Conical papillæ, scattered over whole surface of the tongue; *h* Point of tongue; *i i* Fungiform papillæ seen on borders of the tongue.

THE TONGUE.

The Tongue is a very complicated organ, for it consists of a great variety of parts, and performs a great variety of functions; and although we have arranged it here as one of the organs of deglutition, it is, besides—a glandular organ, to secrete; a sentient organ, to feel and taste; and, likewise, an intellectual organ, to assist in producing speech.

The tongue is divided into apex, body and root; the apex is the anterior free and sharp portion; the root which is thin, is attached to the os-hyoides and is posterior; while the body, which occupies the centre, is thick and broad; it is confined in its situation by the origins of its component muscles, and by reflections of the mucous membrane, to be noticed hereafter.

The upper surface is rough from numerous eminences called the papillæ—which are distinguished into: 1. The Lenticular; 2. The Fungiform; 3. The Conical; and, 4. Filiform papillæ.

The *Lenticular* are the largest in size, situated at the root of the tongue, are nine or more in number, and arranged after the manner of the letter V, with the concavity looking forwards.

They are, generally, conical in shape, surrounded by a slight annular elevation, and consist simply of mucous follicles like those of the lips, palate, etc. Behind these is observed a depression called the foramen cæcum, into which open a group of lingual glands.

The *Fungiform* are next in size, and more numerous; they are found near the borders of the tongue, and present a rounded head supported on a thin pedicle.

The *Conical* are still more numerous, and are seen scattered over the whole surface of the tongue, reaching from the lenticular glands to the apex. They are minute and tapering, and resemble small cones.

The *Filiform* papillæ are the smallest of all, and occupy the intervals between the others, and are also found at the apex of the tongue.

All these papillæ, except the lenticular, from their being so freely supplied with mucous and blood vessels, and having a peculiar arrangement, belong essentially to the function of taste.

The great body of the tongue, however, is muscular in its structure, and its muscles are as follows:

1. The Stylo-Glossus.
2. Hyo-Glossus.
3. Genio-Hyo-Glossus.
4. Lingualis.

These constitute the muscles proper of the tongue. But there are some others which act more or less indirectly on the tongue and lower jaw. They are

1. The Digastricus,
2. The Mylo-Hyoideus, and
3. The Genio-Hyoideus.

The *Stylo-Glossus* arises from the point of the styloid process and stylo-maxillary ligament. It is inserted into the side of the tongue near its root, its fibres running to the tip.

The *Hyo-Glossus*—a thin, broad, quadrilateral muscle, has its *origin* from the body, cornu, and appendix, of the os-hyoides, and is *inserted* into the side of the tongue, forming the greater part of its bulk.

FIG. 40.

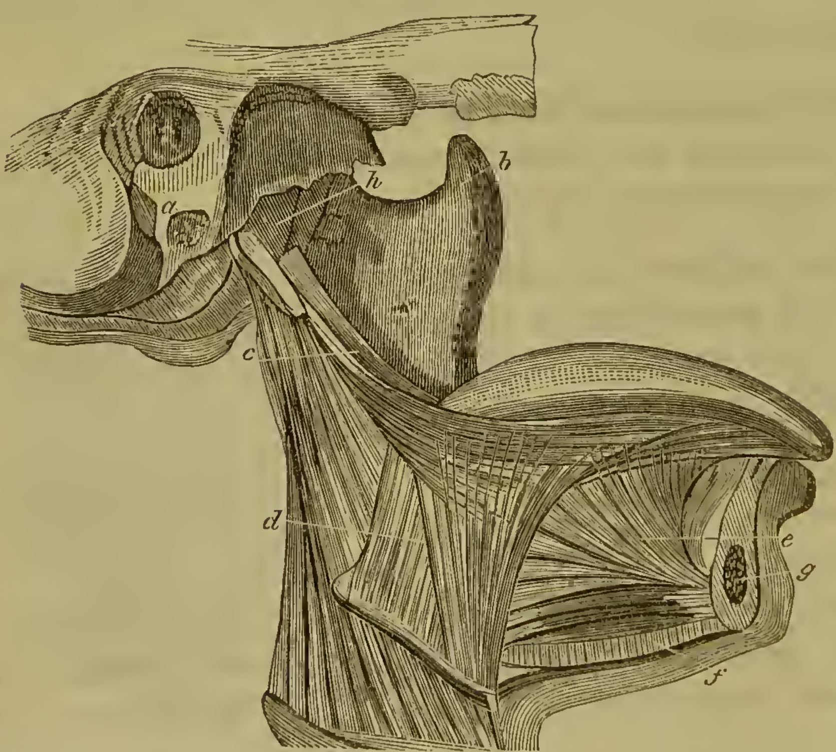


FIG. 40. Lateral view of tongue and its principal muscles: *a* Mastoid process; *b* Coronoid process; *c* Stylo-glossus muscle; *d* Hyo-glossus muscle; *e* Genio-hyo-glossus muscle; *f* Genio-hyoid muscle; *g* Section of lower jaw at symphysis; *h* Styloid process.

The *Genio-Hyo-Glossus* is a triangular muscle, situated on the inside of the last, and having its *origin* from the upper tubercle on the posterior symphysis of the lower jaw, and its *insertion* into the body of the os-hyoides and the whole length of

the tongue from its base to its apex. The fibres of this muscle radiate in various directions through the tongue.

The *Lingualis* has its *origin* on the under surface of the tongue, extending from its base and the hyoid bone to the apex, and so intermingling with the other muscles as to be considered rather a part of them than a distinct muscle.

The *Digastricus*, as its name implies, consists of two bellies united in the middle by a tendon which passes through the insertion of the stylo-hyoid muscle, and is attached to the hyoid bone. Of the two bellies, one is posterior, and occupies the fossa at the end of the mastoid process of the temporal bone; the other is anterior, and extends from the os-hyoides to the base of the lower jaw by the side of the symphysis.

The *Mylo-Hyoideus* forms the floor of the mouth and is a broad plane of muscular fibres, having its *origin* from the myloid ridge on the posterior surface of the inferior maxilla, and its *insertion* into the body of the os-hyoides.

The *Genio-Hyoideus* is a short, round muscle beneath the last, and has its *origin* from the lower tubercle on the back of the symphysis of the lower jaw, and *insertion* into the body of the os-hyoides.

All these muscles, by their separate or combined action, have the power of throwing the tongue into every possible variety of position and motion concerned in the functions of deglutition, suction and speech. They can elevate, depress or turn the tongue to either side; they can protrude it from the mouth or draw it back to the pharynx; make its upper surface or dorsum either convex or concave; and, finally, can turn the tip, as is well known, either upward, downward, backward or laterally.

THE MUCOUS MEMBRANE LINING THE MOUTH.

The whole interior cavity of the mouth, palate, pharynx and lips, is covered by mucous membrane, forming folds or duplicatures at different points, called fræna or bridles. Beginning at the margin of the lower lip, this membrane can be traced

lining its posterior surface, and from thence reflected on the anterior face of the lower jaw, where it forms a fold opposite the symphysis of the chin—the frænum of the lower lip; it is now traced to the alveolar ridge, covering it in front, and passing over its posterior surface, where it enters the mouth. Here it is reflected from the posterior symphysis of the lower jaw to the under surface of the tongue, where it forms a fold or bridle called the *frænum linguæ.* It now spreads over the tongue, covering its dorsum and sides to the root, from whence it is reflected to the epiglottis, forming another fold; from this point it can be followed, entering the glottis and lining the larynx, trachea, etc.

In the same way commencing at the upper lip, it is reflected to the upper jaw, and at the upper central incisors forming a fold, the *frænum* of the upper lip; from this it passes over the alveolar ridge to the roof of the mouth, which it completely covers, and extends as far back as the posterior edge of the palate bones; from this it is reflected downwards over the soft palate; or, more strictly speaking, the soft palate is formed by the duplicature of this membrane at this point, between the folds of which are placed the muscles of the palate already described.

From the palate it is traced upward and continuous with the membrane lining the nares, and downward with the same lining the pharynx, œsophagus, stomach and intestinal canal.

The mucous membrane, after entering the nostrils and lining the roof, floor, septum nasi and turbinated bones, enters the maxillary sinus between the middle and lower spongy bones, and lines the whole of this great and important cavity of the superior maxilla.

Many mucous glands or follicles, already enumerated, are scattered over the whole of this membrane, and furnish the mouth with its mucus.

As this membrane passes over the superior surface of the alveolar ridge of both jaws, its texture becomes changed, and receives the name of gums.

THE GUMS.

The gums are composed of thick, dense, mucous membrane, adhering to the periosteum of the alveolar processes, and closely surrounding the necks of the teeth, where they are reflected upon themselves, forming a free border or margin, presenting a scalloped or festooned appearance. The longest portions are situated in the interdental spaces between the teeth. The reflected portion unites with the periosteum of the roots at the necks of the teeth, and becomes continuous with it. The texture of the gums differs materially from that of the membrane with which they are covered. Externally, it is very similar to this membrane, but internally, it is fibro-cartilaginous. The gums, when in a healthy state, vary in thickness from one-third to three-fourths of a line.

The gums are remarkable for their insensibility and hardness in the healthy state, but exhibit great tenderness upon the slightest injury, when diseased.

In the infant state of the gums, the central line of each dental arch presents a white, firm, cartilaginous ridge, which gradually becomes thinner as the teeth advance; and in old age, after the teeth drop out, the gums again resume somewhat their former infantile condition, showing "second-childhood."

The gums being endowed with a high degree of vascularity, indicate very correctly, as the author has stated in another part of the work, the state of the constitutional health.

THE ALVEOLO-DENTAL PERIOSTEUM.

This membrane may be properly noticed here, as it is considered by some as continuous with the gums. It lines the *alveolar cavities*, or sockets of the teeth, covers the roots of each, is attached to the gums at the necks, and to the blood-vessels and nerves where they enter the roots of the teeth at their apices; and, further, Mr. Thomas Bell believes it passes into the cavities of the teeth, forming their lining membrane, and is continuous with, or the same as that of the pulp.

The original sac has been stated in another place to consist of two membranes, an outer and an inner; these are attached to the gums, and when the teeth come through these membranes and the gums, the sac remaining behind, especially its outer

coat, is supposed by some to constitute the alveolo-dental periosteum, and to be continuous with the gums—while, on the other hand, Mr. Bell believes both membranes of the sac to be wholly absorbed; and that the true alveolo-dental periosteum is the same as the periosteum covering the upper and lower maxillary bones, continuing into the alveolar cavities, lining their parietes, and thence being reflected on the roots of the teeth.

It matters little whether this membrane be a continuation of the gums, the remains of the pulp sac, or the extension of the periosteum of the maxillary bones into the alveolar cavities, since the great practical truth still remains, that there is a membrane lining the alveolar cavities and investing the roots of the teeth, and that this membrane is fibrous, and constitutes the bond of union between the alveolar cavities and the roots of the teeth.

The *Dental Ligament*, so recently discovered by a dentist, formerly of Virginia, but now of Philadelphia, as attached to the necks of the teeth, and whose opinion, I am sorry to add, has the support of Dr. Goddard, bears no more resemblance to true ligament than the nails do to bone. It consists of the fibres that unite the alveolar to the dental periosteum, and which, according to the last-named gentleman, "are very numerous just at the margin of the alveolus;" but it can lay no reasonable claim to the title of ligament.

CHAPTER FIFTH.

BLOOD-VESSELS OF THE MOUTH.

THE arteries that supply the mouth come from the external carotid. This is a division of the common carotid which arises

FIG. 41.

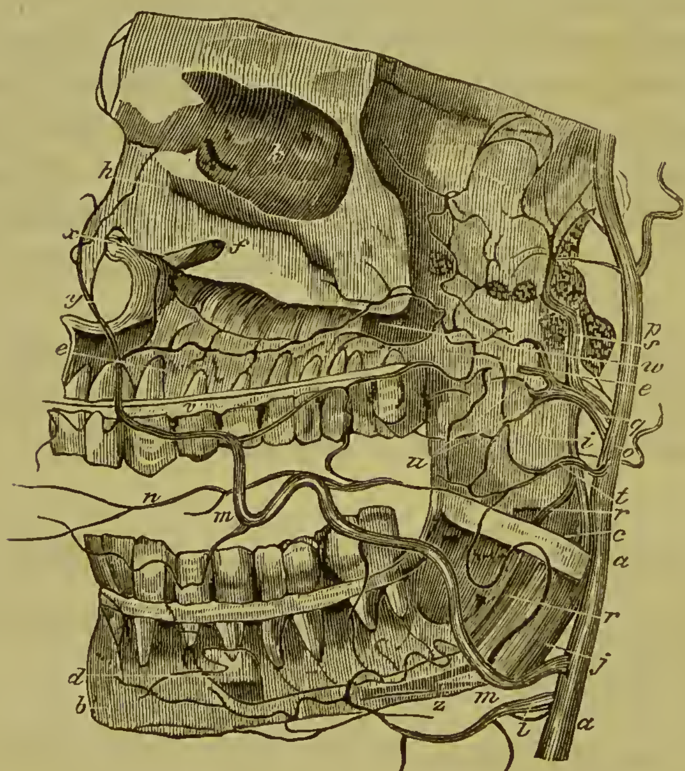


FIG. 41. A view of the arteries supplying one side of the mouth and face: *a a* External carotid artery; *b* Inferior maxillary bone with the antorior plate removed so as to expose the roots of the teeth and the inferior dental artery; *c* Posterior mental foramen, through which the inferior dental artery passes; *d* Anterior mental foramon, where tho same artery comes out to supply the muscles of the lower lip; *e e* Superior maxillary bone, with the lower part of the anterior and outer wall removed, showing the arteries going to the roots of the teeth and cavity of the antrum; *f* Infra-orbital foramen, through which passes the infra-orbital artery; *h* Nasal process of superior maxillary bone; *i* Pterygoidens internus muscle; *j* Angle of inforior maxillary bone; *k* Orbit of the eye; *l* Superior thyroid artory; *m m* Facial artery; *n* Torminating branch of the lingual artery; *o* Termination of extornal carotid into the temporal and internal maxillary branches; *p* Temporal artery; *q* Internal maxillary artery; *r r* Inferior dental artory; *s* Deep temporal branch; *t* Transverse artery of tho face; *u u* Muscular branches; *v* Alveolar branch; *w* Posterior dental branch; *x* Terminal branch of infra-orbital artery; *y* Nasal branch of the facial; *z* Submental branch.

on the right side from the arteria-innominata, and on the left from the arch of the aorta; after passing up the neck on either side along the course of the sterno-cleido mastoid muscles, it

divides on a level with the top of the thyroid cartilage into its two great branches—the external and internal carotid arteries.

The *Internal Carotid Artery* has a tortuous course, is first to the outside and behind the external carotid; then ascends in front of the vertebral column by the side of the pharynx and behind the digastric and styloid muscles to the carotid foramen in the petrous portion of the temporal bone—thence it traverses the canal in this bone and enters the brain, supplying it with the most of its vessels, not giving any to the mouth.

The *External Carotid* (*a a* Fig. 41) extends from the top of the larynx to the neck of the condyle of the lower jaw; at first anterior and on the inside of the internal carotid, it soon gets to the outside, then passes under the digastric and stylo-hyoid muscles and lingual nerve, becomes imbedded in the parotid gland, and terminates between the neck of the inferior maxilla and the auditory meatus in the temporal and internal maxillary arteries.

The branches of this artery supply all the organs belonging to the four primary stages of digestion, namely, those of *Prehension*, *Mastication*, *Insalivation*, *and Deglutition*.

ARTERIES OF THE ORGANS OF PREHENSION.

These belong, principally, to the lips, and come chiefly from the facial artery.

The *Facial Artery* is the third branch of the external carotid. It ascends to the submaxillary gland, behind which it passes on the body of the lower jaw—thence it goes in front of the masseter muscle to the angles of the mouth, and, finally, terminates at the side of the nose by anastomosing with the ophthalmic arteries.

In its course it gives off the submental, inferior labial, superior and inferior coronary arteries, which mainly supply the elevators, depressors, and circular muscles of the mouth—those agents concerned in the first steps of digestion, the prehension of the food.

ARTERIES BELONGING TO THE ORGANS OF MASTICATION.

These are derived from the internal maxillary and the temporal—the two terminating branches of the external carotid.

The *Internal Maxillary Artery* commences in the substance of the parotid gland; then goes horizontally behind the neck of the condyle of the lower jaw to the pterygoid muscles, between which it passes, and then proceeds forward to the tuberosity of the superior maxillary bone; from thence it takes a vertical direction upward between the temporal and external pterygoid muscles to the zygomatic fossa, where it again becomes horizontal, and, finally, ends in the spheno-maxillary fossa by dividing into several branches.

Those branches of the internal maxillary supplying the passive organs of mastication, or the superior and inferior maxillary bones, and the teeth, are,

1. Inferior Maxillary or Dental Artery,
2. The Alveolar or Superior Dental,
3. The Infra-Orbital,
4. The Superior Palatine, and
5. The Spheno-Palatine.

The *Inferior Dental Artery* enters the inferior dental foramen of the lower jaw, passes along the dental canal beneath the roots of the teeth; sending up, in its course, a twig through the aperture of each to the pulps of the teeth, and, finally, escapes at the mental foramen on the chin; a branch of it, however, continues forward to supply the incisors.

The *Superior Dental Artery* winds around the maxillary tuberosity from behind forward, sending off twigs through the posterior dental canals which supply the molars and the maxillary sinus; while the main branch is continued forward, furnishing the gums.

The *Infra-Orbital Artery* enters the infra-orbital canal, traverses its whole extent, and comes out at the foramen of the same name, upon the face; just before it emerges it sends through the anterior dental canal a twig for the incisors and cuspids.

The *Superior Palatine* descends behind the superior maxillary bone, passes through the posterior palatine canal to the roof of the mouth, and supplies the palate, gums, and velum pendulum palati. It also sends off a small branch through the foramen incisivum to the nose.

The *Spheno-Palatine*, entering the back part of the nose through the spheno-palatine foramen, is distributed upon the pituitary membrane.

The arteries supplying the *active organs of mastication*—the temporal, masseter, and pterygoid muscles—are:

The temporal, anterior and posterior deep; the pterygoid and masseteric branches of the internal maxillary artery; while the *temporal artery*, which is the other terminating branch of the external carotid, gives off the middle temporal artery to the temporal muscle, and a branch, the transverse artery, to the masseter.

The *Temporal Artery* begins in the substance of the parotid gland at the neck of the condyle of the lower jaw, mounts over the zygoma in front of the meatus, and ascends about an inch or more, when it divides into anterior and posterior branches.

ARTERIES SUPPLYING THE PARTS CONCERNED IN SALIVATION.

These belong to the salivary glands. The parotid gland is supplied by the posterior auricular, a branch of the external carotid, and by the transverse artery of the temporal. The submaxillary gland is supplied by the facial, and the sublingual by a branch of the lingual artery.

ARTERIES BELONGING TO THE ORGANS OF DEGLUTITION.

The pharynx, soft palate, and tongue, are the organs supplied by these arteries.

The *Arteries of the Pharynx* are the superior and inferior pharyngeal and inferior palatine.

The superior pharyngeal is a branch of the internal maxillary, and is spent upon the upper part of the pharynx, and sends a branch through the pterygo-palatine foramen to supply the arch of the palate and contiguous parts. The inferior is a branch of the external carotid, and in its course upwards towards the basis of the cranium, it sends several branches to the pharynx and contiguous deep-seated parts. The inferior palatine is given off by the facial.

The *Arteries of the Soft Palate* are,
The superior palatine, inferior palatine, and inferior pharyngeal branches.

The *Superior Palatine* is derived from the internal maxillary behind the orbit in the pterygo-maxillary fossa; descends through the posterior palatine canal, comes out on the back part of the roof of the palate through a foramen of the same name, and proceeds inward and forward, supplying the soft palate and the mucous membrane.

The *Inferior Palatine* is a branch of the facial, and passes up between the stylo-glossus and stylo-pharyngeus muscles to the tonsil and soft palate. It also anastomoses with the superior palatine branch of the internal maxillary artery. The inferior pharyngeal is a branch of the external carotid.

The *Arteries of the Tongue* are the *Lingual.* These arteries, on either side, arise from the external carotid, run forward above and parallel with the os-hyoides; then ascend to the under surface of the tongue as far as the tip, under the name of the *ranine* arteries. They give off numerous branches in their course, supplying every part of the tongue.

The mucous membrane of the mouth is principally supplied by the anterior and posterior palatine, and the facial arteries; the gums receive the alveolar and submental branches.

The *Branches* of the *External Carotid* artery as they arise in numerical order, are as follows:

1. The Superior Thyroid.
2. The Lingual.
3. The Facial.
4. The Inferior Pharyngeal.
5. Occipital.
6. Posterior Auricular.
7. Temporal.
8. Internal Maxillary.

The internal maxillary, being the great artery of the mouth, gives off branches in the following order:

Origin, behind the neck of the Condyle.	1. Tympanic Branch, 2. Inferior Dental, 3. Greater Meningeal, 4. Lesser Meningeal.
Origin, between Pterygoid Muscles.	5. Posterior Deep Temporal Artery, 6. Masseteric, 7. Pterygoid Arteries.
Origin, Zygomatic fossa.	8. Buccal Artery, 9. Anterior Deep Temporal, 10. Alveolar or Superior Dental, 11. Inferior Orbital.
Origin, Spheno-Maxillary fossa.	12. Pterygoid or Vidian, 13. Superior Pharyngeal, 14. Superior Palatine, 15. Spheno-Palatine Artery.

THE VEINS.

The veins correspond so nearly, both in name and course with the arteries, that a description of them would be only a repetition of what has been said; suffice it, therefore, to observe, that there are two companion veins with every considerable artery, and that the venous branches are mostly collected at the angle of the jaw into a common trunk called the external jugular vein, which passes down the neck in the course of the fibres of the platysma muscle, and terminates in the subclavian vein at the posterior edge of the sterno-mastoid muscle.

The office of the veins is to return the blood to the heart.

CHAPTER SIXTH.

THE NERVES OF THE MOUTH.

THE nerves supplying the mouth belong to the fifth pair, and the portio-dura of the seventh or facial nerve.

FIG. 42.

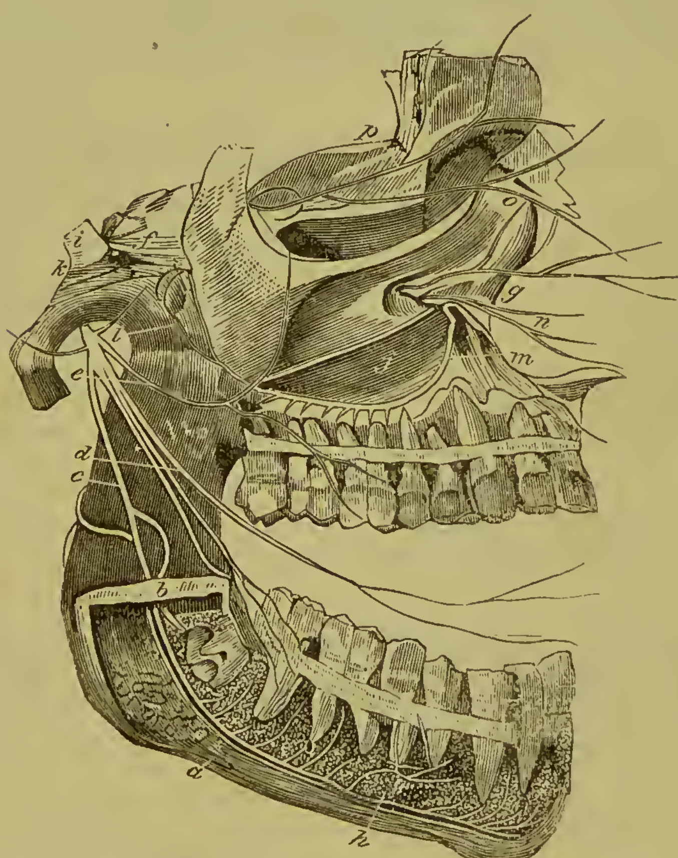


FIG. 42. The fifth nerve with its branches: *a* The inferior maxilliary bone; *b* Inferior dental foramen where the inferior dental nerve enters to supply the teeth; *c* Inferior dental nerve; *d* Gustatory branch of fifth nerve; *e* Muscular branch of inferior maxillary nerve; *f* Ophthalmic nerve; *g* Infra-orbital foramen where infra-orbital nerve comes out; *h* Terminating branches of inferior dental nerve; *i* Casserian ganglion; *j* Internal view of maxillary sinus; *k* Superior maxillary nerve, just where it is given off from the ganglion; *l* Posterior dental branch of superior maxillary nerve; *m* Anterior branch of superior dental nerve; *n* Terminating branches of infra-orbital nerve; *o* Nasal branch of ophthalmic nerve; *p* Frontal branch of ophthalmic nerve.

The *Fifth* (Trigemini) are the largest of the cranial nerves, and give sensibility to all the organs concerned in the primary stages of digestion.

This nerve will also be found to be a compound nerve, having motor filaments as well as sensitive, and thereby giving motion as well as sensation.

It is first seen at the side of the pons Varolii near its junction with the crura-cerebelli—but its origin is much deeper and further back. It arises by two unequal roots, one of which may be traced through the pons Varolii into the restiform body and the floor of the fourth ventricle;—the smaller, or *motor* root, is lost in the medulla oblongata. From its origins this nerve has been called a cranial-spinal nerve.

These two fasciculi, the one anterior and the other posterior, constitute the fifth nerve, which consists of eighty or one hundred filaments that pass forward and outward, in a canal formed of dura mater, to a depression on the anterior surface of the petrous bone.

At this point it spreads into a ganglion, called the Casserian ganglion, on the under surface of which is seen the anterior root; but it has no intimate connection with the ganglion, and can be traced on, as will be presently shown, to the inferior maxillary nerve.

From the ganglion of Casserius proceed three primary branches, namely:

1. The Ophthalmic: the
2. Superior Maxillary: and the
3. Inferior Maxillary Nerves.

The *Ophthalmic Nerve* is a short trunk that enters the orbit through the foramen lacerum superius, and divides into three principal branches,

1. The Frontal,
2. The Lachrymal, and
3. The Nasal.

The *Frontal* passes along the roof of the orbit to the supra-orbital foramen, through which it passes, and is then called the supra-orbital nerve, and is spent on the muscles and integuments of the forehead. It gives off several branches in its course.

The *Lachrymal*, as the term implies, goes to the lachrymal

gland, taking the outward direction, and sending branches in its course to the upper eyelid, conjunctiva and other parts.

The *Nasal* takes its direction along the inner side of the orbit to the anterior ethmoidal foramen, through which it passes into the cranium, on the upper surface of the cribriform plate of the ethmoidal bone; descends by the side of the crista-galli through a slit-like opening into the nose, and there terminates by filaments which are spent upon the septum, mucous membrane, anterior nares, etc. It sends off several branches in its course; one in particular to the lenticular ganglion at the bottom of the eye, others to the caruncula lachrymalis, lachrymal sac, conjunctiva, etc.; but as these do not belong to the mouth and dental apparatus, we will pass to the second great division of the fifth.

THE SUPERIOR MAXILLARY NERVE.

This nerve proceeds from the middle of the Casserian ganglion, passes through the foramen rotundum of the sphenoid bone, into the pterygo-maxillary fossa; here it enters the canal of the floor of the orbit—the infra-orbital canal, traverses its whole extent, and emerges on the face at the infra-orbital foramen, where it terminates in numerous filaments in the muscles and integuments of the upper lip and cheek.

The superior maxillary nerve supplies the upper jaw, and gives off many important branches, which are as follows:

In the pterygo-maxillary fossa two branches descend to a small reddish body called the ganglion of Meckel, or the spheno-palatine ganglion, situated on the outer side of the nasal or vertical plate of the palate bone.

From this ganglion proceed three sets of branches:

1. Inferior, Descending, or Palatine Nerves.
2. Nasal, or Spheno-palatine.
3. Posterior, Pterygoid, or Vidian.

The *Palatine Nerves* descend through the posterior palatine canal, come out at the posterior palatine foramen along with an artery of the same name, and supply with filaments the soft palate, uvula, tonsils, the roof of the mouth, and the inner alveoli and gums.

The *Nasal Nerves* enter the nose through the spheno-palatine foramen, and divide into several filaments which enter the mucous membrane covering the upper and lower turbinated bones and vomer; one long branch can be traced along the septum nasi as far as the foramen incisivum, where it meets the anterior palatine branches in a ganglion called the naso-palatine.

The *Vidian*, or *Pterygoid*, passes backward from the ganglion of Meckel through the pterygoid canal at the root of the pterygoid process; then enters the cranium through the foramen lacerum anterius, and divides into two branches, one of which enters the carotid canal and unites with the sympathetic branches of the superior cervical ganglion, thus connecting this ganglion with the ganglion of Meckel.

The other, the proper vidian nerve, enters the vidian foramen or hiatus Fallopii in the petrous bone, joins the portio-dura nerve, accompanies this as far as the back part of the tympanum; then leaves it, enters the cavity of the tympanum, and receives here the name of *Chorda Tympani.* It leaves this cavity by the glenoid fissure, then joins the gustatory nerve, continues with it to the submaxillary gland, where it leaves it and is lost in the submaxillary ganglion, situated at the posterior part of the submaxillary gland.

The exceedingly intricate course of the vidian nerve is interesting from the number of communications which it establishes between different and distant parts: for it unites the ganglion of Meckel with the superior cervical ganglion of the sympathetic, and both with the submaxillary ganglion; it also connects the superior and inferior maxillary nerves to one another and to the portio-dura.

The *Superior Maxillary Nerve* gives off next in the spheno-maxillary fossa:

1. The Orbital.
2. The Posterior Dental Nerve.

The *Orbital* enters the orbit through the spheno-maxillary fissure, and then sends off a *malar* and *temporal* branch, which pass out through the malar bone; the first supplying the cheek,

the latter accompanying the temporal artery to the integuments of the side of the head.

The *Posterior Dental Nerves*, three or four in number, descend on the tuberosity of the superior maxillary bone, and enter the posterior dental canals to supply the molar teeth; one branch penetrates the antrum and courses along the outer wall, anastomosing with the anterior dental nerves, while another runs along the alveolar border supplying the gums.

The superior maxillary nerve now enters the infra-orbital canal, and becomes the *infra-orbital nerve*, which is its terminating branch.

The *Infra-Orbital* nerve advances through the canal of the same name, and gives off no branch until it arrives at the fore-part; where it sends down along the front of the maxillary sinus, in the anterior dental canal, the *anterior dental nerve*, which divides so as to supply the incisors, cuspids and bicuspids, and also the mucous membrane lining the antrum.

This nerve now emerges, as before mentioned, at the infra-orbital foramen, between the levator labii superioris alæque nasi and levator anguli muscles, dividing here into many branches; some of which ascend to the nose and eyelids, others pass downward and outward to the lip and cheek, anastomosing with the nasal branch of the ophthalmic, and the facial branches of the portio-dura.

INFERIOR MAXILLARY NERVE.

This nerve forms the third great division of the fifth. It is the largest branch, and passes from the ganglion of Casser through the foramen ovale of the sphenoid bone to the zygomatic fossa.

This nerve, as stated, is attached to the anterior or motor root, and they come together on the outside of the foramen ovale: then in the zygomatic fossa, the inferior maxillary nerve divides into two branches:

1. An External, Superior, or Smaller.
2. An Internal, Inferior, or Greater.

The *External* is the motor branch, and gives off the following filaments to the several muscles:

1. *Masseteric*, crossing the Sigmoid notch to the Masseter Muscle.
2. *Temporal*, Anterior and Posterior Deep, to the Temporal Muscle and Fascia, etc.
3. *Buccal*, to the Buccinator, etc.
4. *Pterygoid*, to the Pterygoid Muscles.

The *Internal* division of the inferior maxillary nerve consists of three branches, all of which are sensitive; they are:

1. The Anterior Auricular,
2. The Gustatory, and
3. The Inferior Dental.

The *Anterior Auricular* passes behind the neck of the lower jaw and in front of the meatus of the ear, and ascends through the parotid gland, over the zygoma along with the temporal artery, and divides into anterior and posterior branches.

In its course it unites with the facial nerve, and supplies the parotid gland, the articulation of the lower jaw, the meatus, and cartilages of the ear and side of the head.

The *Gustatory Nerve*, immediately after its origin, sends a branch to the inferior dental; it then descends between the pterygoid muscles, where the chorda tympani joins it; it now passes along the ramus of the lower jaw, covered by the internal pterygoid muscle, then above the submaxillary glands, and forwards above the mylo-hyoid and between it and the hyo-glossus muscles, accompanied by the duct of Wharton; and finally ascends above the sublingual gland to the lateral, inferior and anterior parts of the tongue.

In its course, MR. HARRISON enumerates the following branches as given off by this nerve:

"First, one or two small filaments to the internal pterygoid muscle. Second, several to the tonsils, to the muscles of the palate, to the upper part of the pharynx, and to the mucous membrane of the gums. Third, the chorda tympani, and some

accompanying filaments to form a plexus, which supplies the submaxillary gland. Fourth, a few branches which descend along the hyo-glossus muscle to communicate with the ninth or lingual nerve. Fifth, a fasciculus of nerves to the sublingual gland and to the surrounding mucous membrane. Lastly, at the tongue it divides into several branches, some pass deep into the tissue of this organ, others, firm and soft, rise toward its surface, and are lost in the mucous membrane and in a small conical papilla near its tip."

The *Inferior Dental Nerve* passes between the pterygoid muscles, then along the ramus of the lower jaw under the pterygoideus internus to the inferior dental foramen, which it enters along with an artery and vein ; it now traverses the inferior dental canal, sending off twigs into all the roots of the molars and bicuspids. Opposite the mental foramen it divides into two branches, the smaller is continued forward in the substance of the jaw to supply the roots of the cuspids and incisors ; while the larger comes out at the mental foramen, is distributed to the muscles and integuments of the lower lip, and, finally, communicates with the facial nerve.

The inferior dental, just as it enters the posterior dental foramen, gives off the *mylo-hyoid* nerve ; this passes forwards in a groove of the lower jaw, and supplies the mylo-hyoid, genio-hyoid and digastric muscles.

THE FACIAL NERVE.

The *Portio-dura* of the seventh or facial nerve is the last nerve to be noticed as particularly belonging to the mouth.

The *Facial Nerve* arises from the medulla oblongata between the olivary and restiform bodies, close behind the lower margin of the pons Varolii ; it then passes forward and outward with the portio-mollis, to the foramen auditorium internum, which it enters and passes on to the base of this opening ; here these two nerves separate, the portio-mollis going to the labyrinth of the ear ; while the facial enters the aqueduct of Fallopius, in which it is joined by the vidian ; it then goes in a curved direction outward and backward behind the tympanum, where

it parts with the vidian, and proceeds on to the stylo-mastoid foramen, from which it emerges. At this point it sends off three small branches:

1. The Posterior Auricular,
2. The Stylo-Hyoid, and
3. The Digastric.

Fig. 43.

Fig. 43. View of the facial nerve, or portio-dura of the seventh pair; *a* Trunk of the facial nerve; *b* Ascending branch; *e* Descending branch; *d* Posterior auricular branch; *e e* Temporal branches; *f f* Malar branches; *g g* Inferior maxillary branches; *h* Posterior or great occipital nerve; *i* Terminal branches of the inferior dental nerve; *j* Terminal branches of infra-orbital nerve; *k k* Supra-orbital nerve and its branches; *l* Orbicularis oris; *m* Zygomaticus major; *n* Zygomaticus minor; *o* Levator labii superioris alæque nasi; *p* Orbicularis palpebrarum; *q* Depressor anguli oris.

The *Posterior Auricular* ascends behind the ear, crosses the mastoid process to the occipito-frontalis muscle.

The *Stylo-Hyoid* is distributed to the stylo-hyoid muscle.

The *Digastric* is distributed to the posterior belly of the digastric muscle.

The facial nerve while deeply imbedded in the substance of the parotid gland divides into two sets of branches, of which one is superior and the other inferior; these two by frequent unions form the *pes anserinus* or *parotidean plexus*, and send branches to the whole of the side of the face.

The upper division, called the temporo-facial, ascends in front of the ear upon the zygoma, accompanies the temporal artery and its branches, supplying the side of the head, ear, and forehead, and anastomosing with the occipital and supra-orbital nerves; a set of branches pass transversely to the cheek, furnishing the lower eyelid, lips, side of the nose, and uniting with the infra-orbital nerve.

The inferior or cervico-facial division descends, supplying the lower jaw and upper part of the neck, giving off the following branches:

1. Buccal,
2. Inferior Maxillary, and
3. Cervical.

The *Buccal*, or superior branches, supply the muscles of the cheek, nose, and upper lip.

The *Inferior Maxillary* nerves are distributed in the muscles of the chin and lower lip, and by means of anastomodic branches communicate with the inferior dental nerve.

The *Cervical* branches form a close connection with the superior cervical nerves, and supply the platysma-hyoid muscle.

The facial is the motor nerve of the face, and by its means the passions or emotions find their expression in the peculiar action of the muscles to which it is distributed. According to the system of Sir Charles Bell, the *seventh* is one of the respiratory nerves.

In consequence of the numerous communications which this nerve has with other nerves, the name of *Sympatheticus Minor* has been given to it by some anatomists.

Having now very briefly described the anatomical elements of the several organs of the mouth, it may be well to notice, in conclusion, the anatomical and physiological relations of this cavity.

ANATOMICAL RELATIONS OF THE MOUTH.

The mouth has many interesting anatomical relations with the rest of the body, a few of which it may be well to mention.

By means of its lining mucous membrane it is connected through continuity of structure with the pharynx, œsophagus, stomach, and the whole of the intestinal canal, &c.

Disease still further establishes this structural relation. Inflammation, ulceration, or any other pathological change in the stomach or intestines is felt and reported on the tongue, gums, and other parts of the mouth, showing the sympathy and the close relationship of these several parts.

The mouth is also connected by the same mucous membrane with the organs of respiration by being continued down into the larynx, trachea, and bronchi.

Wide spread sympathies are established between the mouth and other parts by means of the numerous nerves which animate the parts constituting its boundaries and lying in its cavity, as the sympathetic, the seventh, the glosso-pharyngeal, the par-vagum, the hypoglossal, and the upper cervical.

Simple irritation from teething has frequently thrown children into convulsions, and in adults tooth-ache often creates extreme irritability of the whole nervous system. But it is not necessary to dwell here on the sympathies of the mouth in disease with other parts of the body, as the author will have occasion to do this in other parts of the work. It will be well, however, to mention in this place that there is a general anatomical relation of the mouth with the rest of the body, by means of the blood-vessels and areolar tissue.

PHYSIOLOGICAL RELATIONS.

It has been shown that the mouth consists of a great variety of parts, and, also, that it has an equally great diversity of functions.

The fuctions of the mouth have been stated to be those of prehension, mastication, insalivation and deglutition.

These functions, it has been seen, are all closely related to one another, and mutually dependent; and how beautiful is the harmony of action as well as its regular and orderly succession! We see, in the first place, the prehensile instruments laying hold of and introducing the food into the mouth; then the organs of mastication, the teeth and upper and lower jaw bones, put into operation by the temporal, masseter and pterygoid muscles, grind it down into minute portions; these at the same time are formed into a bolus by being mixed with the salivary fluids, furnished by the parotid, submaxillary and sublingual glands; then the mass is taken by the organs of deglutition, namely, the tongue, palate and pharynx, and passed into the œsophagus, to be thence conducted into the stomach, thus demonstrating the harmony existing among the several functions belonging to the mouth.

But the functional relation of the mouth is no less extensive than its structural relation; the one is commensurate with the other; and as the structure of the mouth has been shown to be continuous with that of other parts of the body, so we find that the functions of the mouth exert an influence upon, and are themselves influenced by many great and leading functions of the body. The connection between mastication and insalivation, for example, with stomachal digestion, or chymification, is especially obvious.

Again, the mouth is intimately related with the intellectual functions, as for instance, that of speech. Who does not know that when any of the teeth are wanting, the palate cleft, or there is a hare-lip, how much the speech is impaired? And so with all the other functions of the body; the relation between them and the mouth, and the mutual dependence of each on the other, is equally demonstrable.

The *Origin, Formation* and *Development* of the Teeth ought now to engage attention, and to these subjects the next chapter is devoted.

CHAPTER SEVENTH.

ORIGIN AND FORMATION OF THE TEETH.

Of all the operations of the animal economy, none are more curious or interesting than that which is concerned in the production of the teeth. In obedience to certain developmental laws, established by an all-wise Creator, it is carried on from about the sixth week of intra-uterine existence, with the nicest and most wonderful regularity until completed, but so secretly conducted, as to prevent the closest scrutiny from detecting with precision the manner in which it is effected; enough, however, is ascertained from its progressive results to excite in the mind of the physiologist the highest admiration.

From small papillæ, observable at a very early period of fœtal life, situated in a groove lined with mucous membrane, and running along the alveolar border of each jaw, the teeth are gradually developed. As they increase in size, the papillæ assume the shape of the crowns of the several classes of teeth they are respectively destined to produce. Having arrived at this stage of their formation, they now begin to dentinify, first upon the cutting edges of the incisors, the apices of the cuspids, bicuspids and eminences of the molars; from thence the process is continued over the whole surface of their crowns, until they become invested with a complete layer of dentine; and so layer after layer is formed, one within the other, until the process of solidification is completed. But before it has progressed very far, the enamel of the teeth begins to form, and this formative operation is gone through with previously to the completion of the dentinification of the pulps.

In the meantime, and in anticipation of the fall of the temporary teeth, a second set is forming, and as the teeth of the one series are removed, they are promptly replaced by those of the other. Thus, by a beautiful and most admirable provision of nature, the first set of teeth, intended to subserve the wants only

of childhood while the jaws are too small for the reception of such as are required for an adult, are removed and replaced by a larger, stronger and more numerous set.

The older writers, regarding a knowledge of the earlier stages of the development of the teeth as not of much importance, paid little attention to the subject, and hence this most curious and interesting department of developmental anatomy has remained, until recently, measurably uncultivated. EUSTACHIUS, we believe, was the first to notice the position and arrangement of the teeth in the jaws previous to their eruption. But his researches were confined to the examination of the jaws after birth, at which period he speaks of having discovered, by dissection, the incisors, cuspids and three molars on each side, in each jaw, partly in a gelatinous and partly in a solidified condition. He also discovered the incisors and cuspids of the permanent set behind the first.

Eustachius wrote in 1563, and nineteen years later, URBIAN HEMARD, a French anatomist and surgeon, although unacquainted with the work of the former, gave a very similar description of the situation of the crowns of the incisors and cuspids of both sets in the jaws of an infant at birth. He represents them as partly bony and partly mucilaginous. He also discovered the bicuspids, but he was unable to find the molars at so early a period as at birth.

The researches of ALBINUS threw no additional light upon the manner of the formation of the teeth, and little was known concerning the earlier stages of the development of these organs until the time of John Hunter, who informs us that in the alveoli of a fœtus of three or four months, "four or five pulpy substances, not very distinct, are seen." But he says, "about the fifth month the alveolar cavities are more perfect and the pulps of the teeth more distinct," and that the anterior are more advanced than those further back in the jaws. It is at about this age that he dates the commencement of dentinification on the edge of the temporary incisors. The situation and arrangement of the teeth in the jaws at this period he describes very accurately. At the expiration of the sixth or seventh month, he represents the first permanent molar, as having begun to be formed in the tubercle of the upper jaw, and "under and on

the inside of the coronoid process of the lower;" and he states, that the pulps of the permanent central incisors begin to appear in a fœtus of "seven or eight months," and to dentinify "five or six months after birth." The pulps of the permanent lateral incisors and cuspids he says begin to be formed soon after birth; the first bicuspids about the fifth or sixth year, the second bicuspids and molars the sixth or seventh, and the dentes sapientiæ about the twelfth year.

Although Mr. Hunter gives a more minute and accurate description of the progress of the formation and arrangement of the teeth in the jaws previously to their eruption than any previous writer; yet with regard to their origin and appearance during the earlier stages of their development he is unsatisfactory. Nor do the researches of Jourdain, Blake, Fox, Cuvier, Serres, Delabarre and other writers, throw much additional light upon the subject. In fact, they could not, as their researches do not seem to have been commenced at periods sufficiently early in fœtal subjects; and even from the time when they were first instituted, the progress of the organs does not appear to have been traced through the subsequent stages of their formation with the requisite degree of care and accuracy. It is not, therefore, necessary to notice the description given by these authors of the progress of the formation of the teeth, although it may not be amiss to state here, that Dr. Blake describes the rudiments of the permanent teeth as originating from the sacs of the temporary, and that this supposed discovery has been confirmed by almost every subsequent writer upon the subject.* Indeed, until quite recently, this has been the prevailing opinion, and their progress, step by step, from the time when the rudiments of these teeth are apparently given off as small bud-like processes from the sacs of the temporary, is traced with a degree of minuteness by Mr. Thomas Bell that would seem to preclude the possibility of deception. This last named gentleman describes the process as commencing at a very early period of the formation of the temporary teeth, and as first perceivable "in a small thickening on one side of the parent sac," which,

* It is said, but with how much truth the author is unable to say, that this supposed discovery was made about twenty years before the publication of Dr. Blake's Inaugural Dissertation, by a French dentist by the name of Herbert.

"gradually increasing," becomes "more and more circumscribed; until it at length assumes a distinct form, though still connected with it by a peduncle, which," he says, "is nothing more than a process of the investing sac." "For a time," continues Mr. Bell, "the new rudiment is contained within the same alveolus with its parent, which is excavated by the absorbents for its reception, by a process almost unparalleled in the annals of physiology. It is not produced by the pressure of the new rudiment, as is erroneously believed, but commences in the cancelli of the new bone, immediately within its smooth surface, thus constituting what may be termed a process of anticipation. The new cell, after being sufficiently excavated, and as the rudiment continues to increase, is gradually separated from the former one by being more and more deeply excavated in the substance of the bone, and also by the deposition of a bony partition between them; and at length the new rudiment is shut up in its proper socket, though still connected with the temporary tooth by a cord or process of the capsule already described, which has in the meantime been gradually attenuated and elongated."*

Now it would hardly seem possible for a man of Mr. Bell's accuracy of observation, after having investigated the subject as closely and thoroughly as he must have done, to have enabled him to describe so minutely the various stages of the progress of the development of the permanent teeth, to have mistaken their origin; yet that he has would appear, by subsequent researches, to be rendered certain. I allude to those of ARNOLD and GOODSIR.

The last named author has traced the progress of the teeth, almost from the moment of the appearance of the germs of the first set, as simple mucous papillæ, until the completion of those of the second; and so minutely and accurately, that little remains to be done by future anatomists for the perfection of this branch of odontology.

* This cord has been noticed and minutely described by several other writers. Delabarre calls it the appendage of the dental matrix, and traces it through what is usually denominated the alveolo-dental canal, which he designates by the name of *iter dentis*, to the surface of the gum behind the temporary teeth. He also states that it is hollow, and when he first described it in his thesis of reception in 1806, it had not been noticed by any other writer.

Relying upon the accuracy of his researches, which are described, at length, in the Edinburgh Medical and Surgical Journal for January 1st, 1839, we shall proceed to give a brief summary of their result, as the length of the paper is such as to preclude its insertion entire.

His investigations were commenced in an embryo at the sixth week, at which period a deep groove, formed by two semi-circular folds, extending around each jaw, may be perceived, lined with mucous membrane, and as this gradually widens from behind forwards, a ridge, commencing posteriorly and running in the same direction, rises from its floor, and divides the original groove into two others; the outer one forming the duplicature of mucous membrane from the inside of the lip to the outside of the alveolar process; the inner one constituting what may be very properly denominated the *primitive dental groove*, as the germs of the teeth appear in it.

Fig. 44.

Fig. 44. Upper jaw of human fœtus at the sixth week; *a* The lip; *b* Primitive dental groove.

The inner lip of the inner groove is formed by the outer edge of a semi-circular lobe which is to constitute the future palate. By the seventh week after conception, the germ of the first temporary molar in the upper jaw may be seen in the *primitive dental groove*, rising up from the mucous membrane lining its floor in the form of a *simple free granular papilla*, of an ovoidal shape—the long diameter of which is antero-posterior. By the eighth week, another papilla, of a rounded and granular form, is observable, between the middle and anterior curve of the ridge, on the floor of the same groove,

Fig. 45.

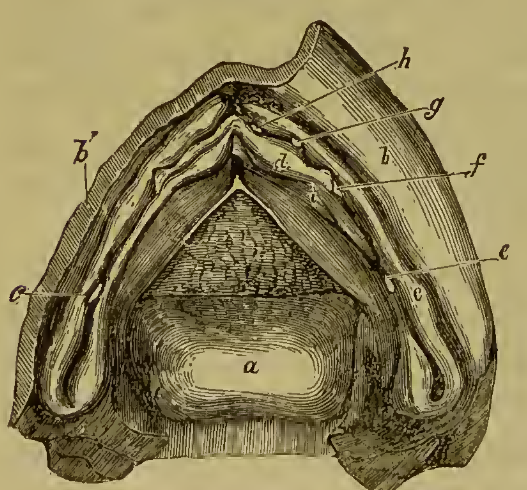


Fig. 45. Lower jaws of human embryo at the ninth week of intra-uterine life, (from Kölliker;) magnified nine diameters: *a* Tonguo thrown back; *b* Right half of tho lip depressed; *b* Left half cut off: *c* Outer alveolar wall; *d* Inner alveolar wall, *e Papilla* of the first molar; *f Papilla* of the cuspid; *g* Of the second incisor; *h* Of tho first incisor; *i* Folds whero the *ducti Riviniani* subsequently ontor.

which is the rudiment of the temporary cuspid. During the ninth week, the germs of the incisors—the central first, and soon after the lateral—make their appearance in the form also of mucous papillæ. During the tenth week the sides of the groove before and behind the anterior molar papilla have been gradually approaching each other and processes from its sides are sent off, from before and behind this germ, which meet and enclose it in a follicle. In the meantime a similar follicle is gradually forming around the cuspid germ. Towards the end of the tenth week, the papilla of the second or posterior temporary molar shows itself.

The papillæ of the incisor teeth, which, up to this time, have advanced very slowly, now begin to increase more rapidly; and during the eleventh and twelfth weeks, processes are sent off from the outer and inner walls of the groove, forming for each a distinct follicle, and while the papillæ of the cuspid and first molar are now undergoing little change, that of the second molar is gradually increasing. During the thirteenth week a follicle is formed for it, and a gradual change takes place in the different papillæ; each begins now to assume a particular shape —the incisors, that of the future teeth—the cuspids "become simple cones,"—the molars "become flattened transversely." The papillæ now "grow faster than the follicles, so that the former protrude from the mouths of the latter, while the depth of the latter varies directly as the length of the fangs of their future corresponding teeth." The mouths of the follicles, in the meantime, are becoming more developed, "so as to form opercula or lids, which correspond in some measure with the shape of the crowns of the future teeth." Of these, the incisor follicles have two—one anterior and one posterior—the first larger than the latter; the cuspid follicles have three—one external and two internal; the molar follicles, as many as there are eminences or tubercles upon the grinding surfaces of these teeth.

The outer and inner lips of the primitive dental groove have increased so much, that at the fourteenth week, they meet together like two valves, so as to give the papillæ the appearance of receding back into their follicles, and to become almost wholly hidden by their opercula. The appearance and progress of the germs of the lower teeth and their follicles are almost precisely

similar to those of the upper, though they do not appear at quite so early a period.

At the epoch last mentioned, the primitive dental groove in each jaw is situated on a higher level than at first, contains the germs and follicles of the ten temporary teeth, and "may now be more properly denominated the *secondary dental groove*," for it is about this time, that provision is made for the production of the ten anterior permanent teeth. It consists in the appearance of a crescent shaped depression immediately behind the inner opercula of the follicles; first, of the central incisors, next of the laterals, then of the cuspids, afterwards of the first bicuspids. The opercula, in the meantime, close the mouths of the follicles, but without adhering to them; beginning with the central incisors, then continuing with the lateral, and the cuspids, and ending with the second molars. The secondary groove is now soon closed by the approach and adhesion of its lips and walls, commencing from behind and proceeding forward; changing the follicles or pits into sacs, the papillæ into the pulps of the temporary teeth, and the crescent-formed depressions into "*cavities of reserve*" from which the pulps and sacs of the teeth of replacement are developed. The *primitive dental groove*, which, by this time, has extended back of the second temporary molar, still retains its original appearance; it has a grayish yellow color, and its edges continue "smooth for a fortnight or three weeks longer" for the development of the papilla and follicle" of the first permanent molar.

The papillæ of the temporary teeth are now gradually moulded into the shape of the dentine of the crowns of the teeth they are destined to form: the pulps of the upper molars are perforated by three canals, and the lower by two, which penetrate to their centre. The primary base is divided into an equal number of secondary bases, from which the roots of the future teeth are gradually to be developed. An intervening space is now formed between the pulps and the sacs, by the more rapid growth of the latter than the former, "in which is deposited a gelatinous granular substance, at first small in quantity, and adherent only to the proximal surfaces of the sacs, but ultimately, about the fifth month, closely and intimately attached to the whole interior of these organs, except for a small space of equal breadth, all round

the base of the pulps, which space retains the original gray color of the inner membrane of the follicle; and as the primary base of the pulp becomes perforated by the canals formerly mentioned, the granular matter sends processes into them, which, adhering to the sac, reserve the narrow space described above, between themselves and the secondary bases. These processes of granular matter do not meet across the canals, but disappear near their point of junction." The granular matter, although not adhering to the pulp, is exactly moulded to all its eminences and depressions.

The outer membrane of the sac, according to Mr. Goodsir, is supplied with blood from small twigs sent off by each branch of the dental artery at the fundus of its destined sac, and from the arteries of the gums, which inosculate with each other, and then ramify in the "true" (inner) membrane.

The follicle of the first permanent molar closes about this time, and has granular matter deposited in its sac, and by the non-adhesion of the walls of the secondary groove, a cavity appears below the sac of this tooth; from the lining mucous membrane of which the second molar germ originates, and from the second sac a new offset shoots forth, destined to contain the papilla of the *dens sapientiæ*.

But previously to this period, the apices and eminences of the temporary teeth have become vascular, and now earthy salts begin to be deposited. Simultaneously with this process, the inner surface of the granular matter is absorbed, and after a while becomes so thin as to render the subjacent vascularity apparent. This continues until, by the time a layer of dentine has formed over the whole surface of the pulp and reached its base, no remains of it are left.

The cavities of reserve have been gradually receding and assuming a position behind the temporary teeth; the distal extremities of the anterior ones begin to distend about the fifth month, and it is here that the germs of the teeth of replacement first appear, and are indicated by a bulging up or folding of this portion of these cavities. These soon acquire the appearance of dental pulps, and the mouths of the cavities gradually become obliterated.

By the sixth month, bony septa have formed across the alveo-

lar groove, and niches are now formed on the posterior walls of the alveoli for the sacs of the permanent teeth. The sac of the first permanent molar remains up to the eighth, and even the ninth month, imbedded in the maxillary tuberosity. The roots of the temporary incisors, at or a little before birth, begin to be formed; in the accomplishment of which, says Mr. Goodsir, "three contemporaneous actions are employed, viz. the lengthening of the pulp; the deposition of tooth substance upon it; and the adhesion of the latter to that portion of the inner sac which is opposite to it." By this time the central incisors appear through the gum, the jaw has lengthened so much, that the first permanent molar begins to assume its proper position in the posterior part of the alveolar arch. The sacs of the permanent teeth continue to recede during the advance of the temporary teeth and their sockets to acquire their perfect state, and to insinuate themselves between the sacs of the former until they are connected by their proximal extremities only, through the alveolo-dental foramina or *itinera dentium* of Delabarre.

FIG. 46.

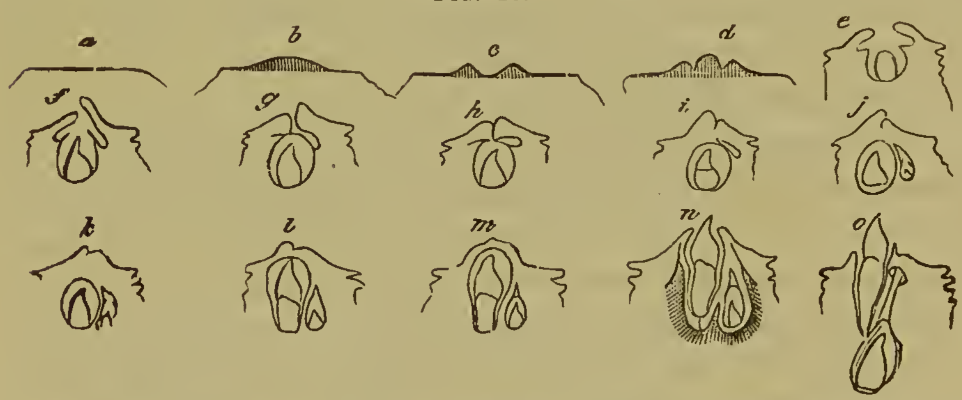


FIG. 46. *a* Mucous membrane; *b* Mucous membrane, with a granular mass deposited in it; *c* The primitive dental groove; *d* A papilla on the floor of the groove; *e* The papilla enclosed in a follicle, and the secondary dental groove forming; *f* The papilla assuming the shape of a pulp, the opercula forming, and a depression for a reserve cavity behind the inner operculum; *g* The papilla becomes a pulp, and the follicle a sac by the adhesion of the lips of the opercula; the secondary dental groove in the act of closing; *h* The secondary groove adherent, except behind the inner operculum, where it has left a shut cavity of reserve for the formation of the pulp and sac of the permanent tooth; *i* The last change more complete by the deposition of the granular body, deposition of tooth substance commencing; *j* The cavity of reserve receding; its bottom, in which the pulp is forming, dilating; *k* The cavity of reserve becoming a sac with a pulp at its bottom, and further removed from the surface of the gums. The temporary tooth covered with a layer of bone, and the granular substance absorbed; *l* The temporary tooth acquiring its root and approaching the surface of the gums; *m* Root of the temporary tooth longer, and its sac touching the surface of the gum; *n* Eruption of temporary tooth, its sac again a follicle, and the permanent receding further from the surface of the gum; *o* Completion of temporary tooth, free portion of sac become the vascular margin of the gum, and the permanent sac connected by a cord passing through the alveolo-dental canal or foramen.

The vessels which go to the sacs of the permanent teeth are derived, first, from the gums, but they ultimately receive vessels

from the temporary sacs, which, uniting with the others, eventually retire into permanent dental canals.

The foregoing diagram, taken from Goodsir, exhibits at one view the origin and progress of the formation of a temporary and its corresponding permanent tooth.

The cavity of reserve, behind the first permanent molar, begins to lengthen about the seventh or eighth month; a papilla soon appears in its fundus, it then contracts and separates from the remainder of the cavity, by which means a new sac is formed—that of the second permanent molar. As the jaw increases in length, it comes downward and forward. The papillæ of the wisdom teeth (dentes sapientiæ) form in the remaining portion of the cavities of reserve, which, in the upper jaw, occupy the maxillary tuberosities, and in the lower, the base of the coronoid processes, which places, says Goodsir, they do not leave until the nineteenth or twentieth year.

The progress of the formation of the three molar teeth will be seen in the diagram, Fig. 47, also copied from Mr. Goodsir.

FIG. 47.

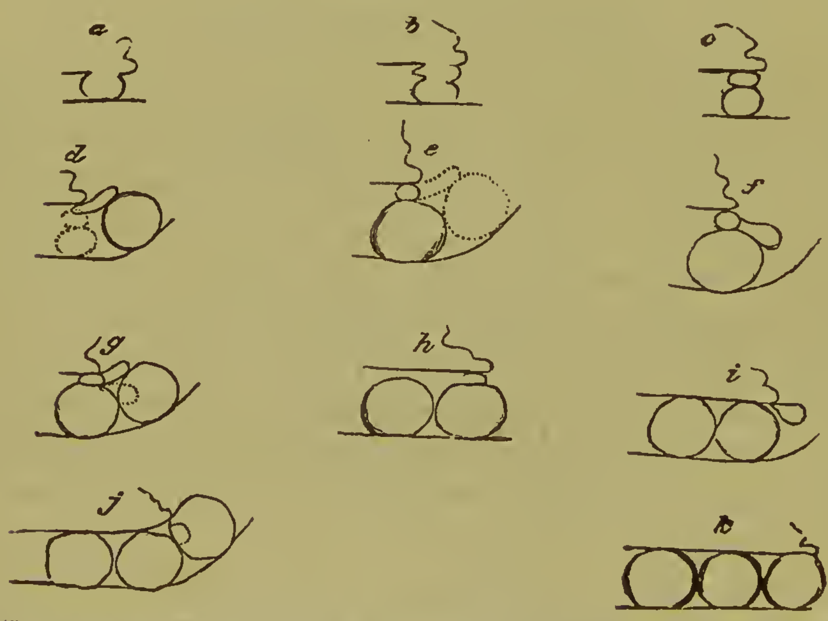


FIG. 47. *a* The non-adherent portion of the primitive dental groove; *b* The papilla and follicle of the first molar on the floor of the non-adherent portion, now become a portion of the secondary groove; *c* The papilla a pulp, and the follicle a sac, and the lips of the secondary groove adhering, so that the latter has become the posterior or great cavity of reserve; *d* The sac of the first molar increased in size, advancing into the coronoid process or maxillary tuberosity, and the cavity of reserve lengthened; *e* The sac of the first molar returned by the same path to its former position, and the cavity of reserve shortened; *f* The cavity of reserve sending backward the sac of the second molar; *g* The sac of the second molar advanced into the coronoid process or the maxillary tuberosity; *h* The second molar sac returned, and the cavity of reserve shortened; *i* The cavity of reserve sending off the sac and pulp of the wisdom tooth; *j* The sac of the wisdom tooth advanced into the coronoid process or maxillary tuberosity; *k* The sac of the wisdom tooth returned to the extremity of the dental range.

From the foregoing abridgement of the description given by Mr. Goodsir of the development of the pulps and sacs of the human teeth, it is seen, that the papilla of the first temporary molar makes its appearance at about the *seventh week* of embryonic life; at the *eighth* week, the cuspid papilla is developed; during the *ninth*, the papillæ of the incisors make their appearance, and by the end of the *tenth* week, the papilla of the second temporary molar may be seen. At the end of the fourteenth week, the upper part of the primitive dental groove, containing the germs and follicles of the ten temporary teeth, becomes the secondary dental groove, from which the papillæ of the teeth of replacement are furnished. The secondary groove assumes the form of crescent-shaped depressions behind the palatine operculа of the follicles of the temporary teeth. The cavities of reserve for the permanent teeth gradually recede, and assume a position behind the sacs of the deciduous teeth, and from the distal extremities of these the papillæ of the replacing teeth are developed.

FORMATION OF THE DENTINE.

With regard to the manner of the formation of the dentine, odontologists do not agree. Mr. Thomas Bell is of the opinion that it is secreted by the external surface of a membrane which immediately invests the pulp, designated by Raschkow the *preformative membrane*, the pulp serving only as a mould upon which this substance is formed. Purkinjé and Schwann believe that the pulp is converted into dentine by a transition process, the superficial cells upon the surface assuming, first, an elongated form, corresponding in diameter and direction with the fibres of the dentine; or, in other words, that the dentine is formed by the dentinification of the pulp.

Professor Owen maintains that it is by "*centripetal calcification* of the pulp's substance." He says, "In the cells of the dentinal pulp the nucleus fills the parent cell with a progeny of nucleoli before the work of calcification (or, more properly, of dentinification) begins." Again, "The primary cells and the capillary vessels and nerves are imbedded in a homogeneous, minutely subgranular, mucilaginous substance. The cells, which

are smallest at the base of the pulp, and have large, simple, subgranular nuclei, soon fall into linear series, directed towards the periphery of the pulp: where the cells are in close proximity with that periphery, they become more closely aggregated, increase in size, and present the following changes in their interior— A pellucid point appears in the centre of the nucleus, which increases in size and becomes more opaque around the central point, rendering the compressorium requisite for its demonstration. A division of the nucleus in the course of its long axis is next observed. In the larger and more elongated cells, still nearer the periphery of the pulp, a subdivision of the nuclei has taken place, and the subdivisions become elongated with their long axis vertical or nearly so to the plane of the pulp, and to the field of calcification. The subdivided and elongated nuclei become attached by their extremities to the corresponding nuclei of the cells in advance; and the attached extremities become confluent. Whilst these changes are in progress, the calcareous salts of the surrounding plasma begin to be accumulated in the interior of the cells, and to be aggregated in a semi-transparent state around the central granular part of the elongated nuclei, which now present the character of secondary cells, and the salts occupy, in a still clearer and more compact state, the interspaces of such cells; the elongated granular matter of the terminally confluent secondary cells establishes the area of the tubes, by resisting, as it would seem, the encroachment of the calcareous salts; the nuclear tracts receiving a similar proportion of the salts, in the condition of minute disintegrated particles, which are usually arranged in a linear series of nodules, and contribute to cause the white color of the moniliform area of the tube, when viewed by reflected light, and its opacity when viewed by transmitted light. Thus the primitive existence of the granular nuclei, their multiplication in the primary or parent cell, their elongated form, their serial arrangement end to end, and terminal confluence, are indicated in the calcified pulp by the area of the dentinal tubes; the interspaces of the metamorphosed nuclei being occupied by calcareous salts in a clearer and more compact state; with evidence, however, of a distinctness of the nucleolar membrane, or secondary cell from the cavity of the common containing cell, which sustains the interpretation of the proper

parietes of the dentinal tube. The indications of the primitive boundary or proper parietes of the parent cell are in like manner more or less distinctly retained, through a modification of the arrangement of the calcareous salts in the boundaries and in the interspaces of the cells." The foregoing is but a small part of the description given by this learned writer, but enough to show his views upon this intricate operation of the economy.

Mr. Alexander Nasmyth says, "The cells of the pulp are converted into ivory" (or dentinal) "cells by the deposition within them of earthy salts, and the cells so converted, with their nuclei, are the perfect ivory; moreover, the nuclei assume a peculiar arrangement and constitute the structure which I have described and demonstrated by the name of baccated fibres." This explanation of the manner of the formation of dentine, designated by Mr. Nasmyth by the name of ivory, differs from that given by Professor Owen in respect of the part taken in the process by the nuclei of the dentine cells, and of the nature of the resultant ivory itself; which, according to Owen, to many of his predecessors and to the most authoritative among his contemporaries, is permeated by an infinity of anastomosing *canaliculi*, while the tubules, more or less marked by constrictions, are recognized by Nasmyth as solid fibres.

Fig. 48.

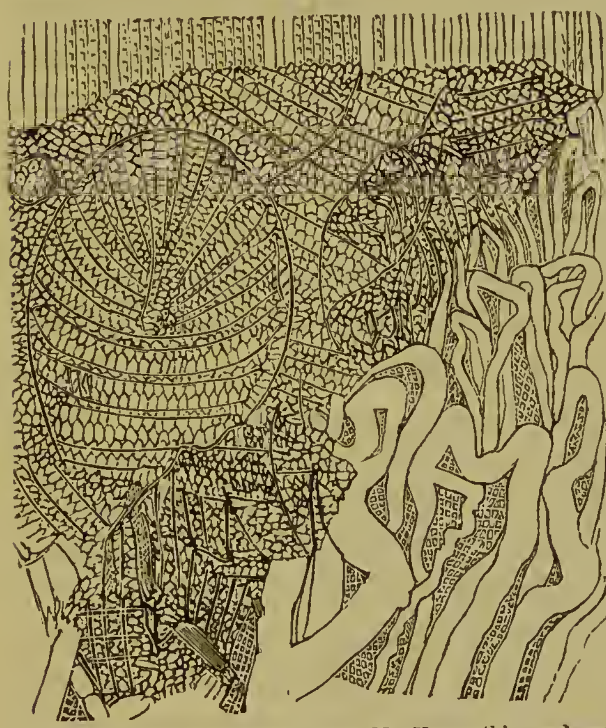


Fig. 48. A diagram copied from Mr. Nasmyth's work on the Development, Structure and Diseases of the Teeth, showing the vascular and cellular structure of the pulp of a tooth, and the conversion of the cells into dentine. *a* "The blood-vessels and capillaries of the pulp, between which the cellular structure is seen." *b* "The cells in process of conversion into ivory," or dentine, "and occupying the peripheral portion of the pulp." "In the line between *c c*, the transition of these cells into the structure of ivory," or dentine, is more clearly exhibited.

The changes which the pulp undergoes a little before and at about the time of the commencement of the deposition of earthy

salts is described more clearly by Mr. Tomes than by any preceding writer. He divides the development of the pulp into three stages. The first, he terms the *areolar;* the second, the *cellular*, and the third, the *linear* stage. The first embraces the period of the earliest appearance of the pulp; the second, from the time when it is composed of nucleated cells and a subgranular uniting medium, to the period when the former begins to assume a linear arrangement; which arrangement immediately precedes dentinification, and constitutes the third stage. The cells nearest to the coronal surfaces are the first to assume this position. The columns thus formed of the cells take an arrangement nearly vertical to the coronal surface, or corresponding to the direction of the dentinal tubes or fibres of the perfected tooth, and running parallel to each other. Scarcely any trace of the areolar tissue seen in the first or earlier stage can be detected in this, the second stage.

FIG. 49.

FIG. 50.

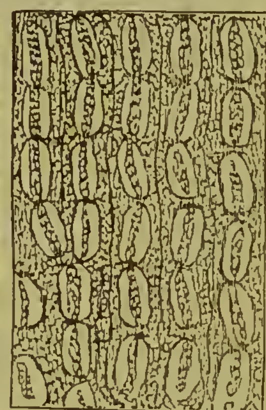


FIG. 49. The pulp in its second stage composed of nucleated cells and subgranular plasma.

FIG. 50. The pulp in the early part of the third stage, showing the cells arranged in lines. Copied from Mr. Tomes.

These three conditions, in the advanced pulp, are not distinguished, according to Mr. Tomes, by well defined lines of demarcation, "but are beautifully blended, the one with the other, passing from the one extreme of condition to the other so gradually that the transitions are not at first recognized, and when fully recognized are again lost in the gradations towards a further change."

The cells decrease in size from the surface toward the central portion of the pulp; but the smaller increase to the size of the larger when the time for their dentinification arrives. Each cell after falling into line, divides lengthwise into two or more, and each division elongates. A central nucleus or open space is seen in each cell, which lengthens with the cell. The cells by their increased length become placed end to end, and ultimately unite; and the elongated central space of each individual, by a

further development, joins with and opens into those of the super-imposed cells; thus forming a central tube common to the linearly united cells," as seen in Fig. 51. "At or a little before this period of development the earthy matter is received into the cellular or rather tubular and intertubular tissue, whereby the gelatinous matrix, having assumed the required form, is converted into tubular and intertubular tissue; in other words into dentine. In some instances the linearly arranged cells have two or even three central cavities, but in the progress of development they become joined in one. Sometimes they appear empty, at other times occupied by granular matter. In either case they are usually described under the name of nuclei." The transparent structureless membrane enclosing the pulp is the first to undergo solidification.

Fig. 51.

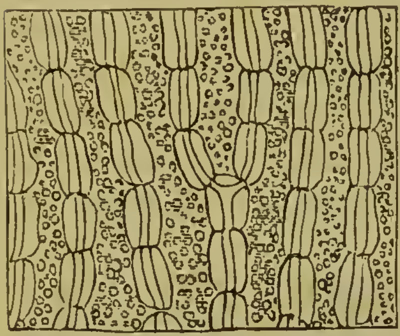


Fig. 51. The pulp in the third stage, showing the cells placed end to end and becoming confluent; also, two lines of cells uniting to form one.

Professor Kölliker entertains very nearly the same opinion with regard to the manner of the formation of dentine as that expressed by Mr. Tomes. After advancing three hypotheses, he concludes by expressing the belief, that the matrix of the dentinal tubes, the intertubular tissue, "proceeds from the cylindrical cells investing the pulp of the tooth, which undergo a greater or less elongation, coalesce and ossify." The canaliculi, or tubes, he believes, either arise from the nuclei of these cells, or, which he believes to be more probable, are the remains of the cavities of the cells, the boundaries having undergone greater consolidation, and which, therefore, correspond with lacunæ of bone. The divisions, he thinks, may be owing to a longitudinal division, from time to time, of the cells, or by the union of one cell with two others.

The foregoing brief summary of the opinions of the authors referred to, will serve to convey an idea of the views at present entertained with regard to the manner of the formation of dentine.

FORMATION OF THE ENAMEL OF THE TEETH.

The opinion formerly entertained upon this subject was, that the enamel is a deposition from the inner membrane of the dental sac; that this, after the surface of the pulp of the tooth has become dentinified, pours out upon the latter a thick fluid, which soon condenses, assuming at first a chalky appearance, and, afterwards, by a process somewhat similar to crystallization, attains the glossy-like hardness by which it is characterized. Recent observations, however, especially those of Raschkow, establish the erroneousness of the views prevailing among older writers.

The gelatinous granular substance mentioned by Goodsir, and called by Raschkow the adamantine organ, situated between the follicle and tooth germ, (the latter of which it invests, at first loosely, but afterwards more closely, moulding itself to the pulp,) there is good reason to believe, is destined for the formation of the enamel. It is represented by the last named author as forming a globular nucleus between the follicle and dental germ at a very early period of the growth of the latter, with a bulging externally, and presenting a parenchymatous appearance internally; but gradually exhibiting angular granulations, held together by filaments of areolar tissue, resembling "a kind of actinenchyma, such as may be seen in plants." It was the discovery of this granular substance in dissecting the jaws of a pig that first induced the writer to suppose the old doctrine of the formation of the enamel to be incorrect. It is at first as represented by Raschkow and Goodsir, disconnected from the dental germ, surrounded by fluid, bearing a striking resemblance to the liquor amnii; but is gradually transformed into a membrane, and as dentinification commences in the pulp, attaches itself to it, and adheres with considerable tenacity.

It was no doubt the discovery of this that led Delabarre to suppose the enamel an integral part of the tooth and proceeding from the dental embryo, for he speaks of the formation of this outer coating of the teeth as being produced by an immense number of small exhalant vessels which form a sort of imperceptible velvet. Into these he believed the phosphate of lime

was deposited, and in such a way as not to destroy their organic sensibility.

Raschkow says, "The dental germ, in advancing further and further into the dental follicle, makes first only a slight impression on the globular mass of the enamel organ, but this impress is rendered gradually deeper as the growth of the germ proceeds. When the germ has penetrated further into the hollow thus made, it appears narrower towards the base, and thicker under the apex, and is enclosed on every side by the parenchyma of the enamel-organ, which thus assumes the appearance of a hood, covering the dental germ when advanced in its development, and capable, by placing it under water, of being separated from it without difficulty, and without injury, either by the compressor, or in any other manner." He also represents it as being disconnected from the dental capsule, except at the coronal portion, where it seems to be united by some loose vessels; it is thus that he accounts for the numerous capillaries which pervade the parenchyma of the organ; and from this, he assumes that while the dental germ has its origin from the extremity of the sac next the root, the enamel-organ originates from the opposite or coronal extremity, and that "arising at opposite points, they approach each other, are adapted together, and both contribute to the production of the tooth."

After the enamel-organ has adapted itself to the dental pulp, a peculiar stratum is seen on its inner surface, consisting of short uniform fibres placed perpendicularly "to the cavity, forming, as it were, a silky lining" to it; which, in a transverse section of the enamel-organ, may be "clearly seen, and can be accurately distinguished from the other stellated parenchyma of the substance," which Raschkow designates the enamel pulp.

According to this author, the stratum of fibres, originating in "the transformation of the pulp of the enamel," with which it is for a time connected, afterwards separates from it, so as only to adhere by "a few filaments of cellular tissue, and becomes a genuine membrane;" this, on account of the function it performs, he styles the enamel membrane. "Its inner surface consists of hexangular, nearly uniform, corpuscles, visible only through a magnifying glass; towards the centre of each of which is a round eminence. These corpuscles are nothing more than

the ends of short fibres, of which the whole membrane is composed; and which being pressed together, assume freely the hexangular form." These he describes as being disposed in regular series, and corresponding with the arrangement of the enamel fibres.

Each of these fibres is an excretory duct or gland, whose peculiar function it is to secrete the "enamel fibre corresponding to it." Immediately after the commencement of dentinification of the pulp, each one of these fibres, with its inner extremity placed upon the now-forming subjacent dentine, begins to secrete the earthy salts of which this substance is chiefly composed. While this is going on, an organic lymph seems to be secreted from the parenchyma of the enamel-membrane which penetrates between the individual fibres, and renders their whole substance soft. This, by means of a "chemico-organic process," afterwards combines with the earthy substances, and forms the animal base of the enamel.

It has been claimed by Raschkow, that the dental pulp is invested by a very delicate membrane, which he denominates the *preformative membrane;* and there is every reason to believe, that this constitutes the bond of union between the enamel fibres and the dentine of the tooth.

Admitting this theory of the formation of the enamel to be correct, the frame work of animal tissue, spoken of by Mr. Nasmyth, as entering into the composition of this substance, is readily accounted for. In no other way, unless the theory of Delabarre be correct, and this is by far the most plausible, can its presence be satisfactorily explained.

With regard to the manner of the formation of *Nasmyth's membrane*, Professor Kölliker inclines to the opinion that it is "a calcified, amorphous exudation, secreted from the enamel organ immediately after the ossification of the last enamel cells, which glues together and protects the ends of the prisms of the enamel." Huxley, on the other hand, believing the enamel to be formed beneath the membrane which invests the pulp, called by Raschkow the *preformative membrane*, is of opinion that Nasmyth's membrane is merely an altered condition of this. His theory, however, of the manner of the formation of the enamel prisms, as well as of the membrane in question, needs confirma-

tion. That part which relates to the formation of the enamel fibres, is little more than a revival of the theory of Delabarre.

FORMATION OF THE CEMENTUM, OR CRUSTA PETROSA.

The manner of the formation of the cementum, has been variously explained. Raschkow conjectures that it is probably produced by the remains of the enamel pulp. More recent writers seem to regard the cemental pulp as a production of the dental sac, but the writer is inclined to believe that it is a production of that portion of the preformative membrane which invests the elongated part of the pulp destined for the formation of the root; and that this, as earthy salts are deposited in the pulp, pours out a blastema in which nucleated cells are developed. He was led to the adoption of this belief from an examination of a tooth, on every part of the surface of which, there is a development of exostosis. Such development is now universally admitted to be a hypertrophied condition of cementum, the structure of the exostosis and of cementum being identical.

The tooth in question belongs to the Museum of the Baltimore Dental College,* and the development of the exostosis must have commenced simultaneously with the commencement of the deposition of earthy salts in the dentinal pulp; and so rapidly did it proceed, that it completely broke up the enamel organ, penetrating every part of it, so that only here and there, imbedded in its substance, small patches of enamel are seen. This phenomenon can only be accounted for by supposing that the investing membrane of the pulp, from some inexplicable cause, poured out a blastema, which was immediately converted into cementum, and that this took on a hypertrophied condition before, or simultaneously with, the deposition of earthy salts in the cells of the fibres of the enamel organ.

* It was presented to the Author, for this institution, by Dr. Swayze.

CHAPTER EIGHTH.

FIRST DENTITION.

The crowns of the temporary teeth, as has been shown, are solidified and coated with enamel at birth, and although at about this period the roots of the incisors begin to be formed, yet the organs still occupy their bony cells in the alveolar ridge. But as the time approaches when the system requires a diet better suited to the support of its increasing energies than milk, the one on which the child has hitherto subsisted, nature, as if conscious of the change about to take place, calls into action certain agents, by which the openings into the alveolar cells are enlarged; and through which, in obedience to an established law, the little gems, sparkling with whiteness, gradually and slowly emerge, pair after pair, until the pearly arches are completed, to answer the demands of increasing wants, and to assist in the articulation of those lisping accents by which the child's early wishes are made known.

Dentition is divided by Mr. Goodsir into three stages, namely, the *Follicular*, the *Sacular* and the *Eruptive*. The two first have already been considered, and it now only remains to treat of the last.

ERUPTION OF THE TEMPORARY TEETH.

Various opinions have been advanced with regard to the manner in which the passage of a tooth, from the alveolus through the gum, is effected. Some suppose it is the result of the elongation of the pulp for the formation of the root; others, that it is a consequence of the moulding of the alveolus around the latter, as it is formed. Some believe that the opening through the gum is effected by the mechanical action of the coronal extremity of the advancing tooth; others, and with far more plausibility, that it is the result of the action of absorbent vessels alone.

The able physiologist and learned dentist, Delabarre, has advanced a most ingenious theory upon this subject. He believes that the passage of a tooth through the gum, or rather its escape from its crypt, is effected in precisely the same manner as is the birth of a child. He regards the sac, attached above to the gum and below to the neck of the tooth, as the chief agent in the eruption, and believes that it is by its contraction that the latter is raised from the bottom of the alveolus, and ultimately forced through the dilated orifice of the capsule and gum.

This is the most rational theory that has been advanced; it explains, upon principles of sound physiology, this most wonderful and curious operation of the economy. It is difficult to imagine how the elongation of the pulp, or the moulding of the alveolar walls to it, can have any agency in forcing the tooth through the gums. If the elongation of the pulp commenced before the crown of the tooth had made any advance towards the gums, it would at once come in contact with the floor of the alveolus, and in its soft and yielding condition be caused to assume a configuration different from that presented by the root of a naturally developed tooth. The crown of the tooth, therefore, must make some progress towards the gum, before the elongation of its pulp can commence, and it is difficult to conceive how this can be effected, even by the contraction of the sac, unless a way be previously or contemporaneously worked out for the advancing crown.

This theory is objected to by some, on the ground that the two membranes of which the dental matrix or sac is composed, are of a fibrous structure, and consequently, not endowed with contractile properties; but the microscope of Mr. Nasmyth has shown that the inner lamina is composed of layers of cells, loosely arranged, and separated by interspaces equal to half the diameter of the cell. In another place, the same writer observes, that the inner lamina seems to partake more of the nature of a serous than of a mucous membrane. That the sac does contract, is proven by the fact, that it shortens as the tooth advances; so that, ultimately, after the complete extrusion of the crown, it constitutes the free edge of the gum.

The dentinification of the exterior of the root of the tooth proceeds nearly as fast as the elongation of the pulp for its forma-

tion. Commencing at the neck, it proceeds inward and downward, forming concentric layers, one within and above the other, until it reaches the extremity; until nothing remains but a small canal running through the centre, from its apex to the cavity in the crown, through which the dental vessels and nerves pass. The alveolus, in the meantime, deepens, its walls approach each other, and closely embrace the root of the tooth.

As soon as the edge of the coronal extremity of the tooth comes through the gum, the sac resumes its primitive follicular condition; but still connected with the neck of the tooth, it continues to contract until the whole of the crown has emerged from the gum.

The periods of the eruption of the temporary teeth are variable, depending probably upon the state of the constitutional health. The following, however, may be regard as a very near approximation, namely:

The central incisors	from	5 to 8	months	after	birth.
" lateral incisors	"	7 to 10	"	"	"
" first molars	"	12 to 16	"	"	"
" cuspids	"	14 to 20	"	"	"
" second molars	"	20 to 36	"	"	"

No general rule, however, can be laid down from which there will not be frequent deviations. The following is the most remarkable case of deviation, not only from the normal period, but also from the natural order of the eruption of the teeth, which the author has ever met with. In November, 1846, he was sent for to lance the gums of an infant only four months old. On examining the mouth, the gums on each side, both in the lower and upper jaws, about where the first temporary molars are situated, were found much swollen and inflamed. As these teeth were evidently forcing their way through the gums, and as the child was threatened with convulsions, it became necessary to lance them immediately. This was accordingly done, to the instant relief of the little sufferer. A few days after, the teeth made their appearance, but the eruption of the central incisors did not take place until about the seventh month.

There is sometimes an extraordinary tardiness of action in the eruption of the temporary teeth. There is a case of a child, on record, that did not cut any of its teeth until it was ten years

old. Lefoulon states that he saw a young girl, seven years of age, whose inferior incisors had not yet appeared. Several cases have come under the observation of the author, in which dentition did not commence until the fifteenth, and in one not until the twentieth month. On the other hand, there are cases of precocity in the eruption of the teeth equally remarkable, as for example, when the two lower incisors appear at birth; such occurrences have been met with. Louis XIV. was born with four teeth, and Polydorus Virgilius mentions a child that was born with six. Haller, in his Elements of Physiology, enumerates the cases of nineteen children who were born with teeth. Other examples are on record, and there are few physicians or dentists who have been in practice ten or fifteen years, who have not met with like cases.

In speaking of those early productions, Mr. Fox says, "As they only have a weak attachment to the gums, they soon become loose, producing considerable inflammation in the mouth of the child, as well as occasioning considerable inconvenience to the mother. It is, therefore, advisable to extract them immediately, for they can never come to perfection." The author is compelled to differ with Mr. Fox, for their attachment is not always, as he supposes, confined to the gums; their roots are sometimes securely fixed in sockets in the jaw. When this is the case, they seldom occasion much inconvenience, and their extraction would be highly improper. It is always better, therefore, to wait until there is some positive indication that such operation is necessary, before performing it.

In the eruption of the teeth, nearly the same order is followed that is observed in their solidification. The central incisors appear first, then the lateral, next the first molars, afterwards the cuspids, and, lastly, the second molars.

The lower teeth in their eruption, are said, usually, to precede the upper by about two or three months, but the upper appear first nearly as often as the lower.

MORBID EFFECTS RESULTING FROM FIRST DENTITION.

When we consider the early age at which first dentition commences, and the fragile and irritable state of the system, it will not appear wonderful that infants should so frequently suffer from the efforts of the economy for the liberation of these organs from the bony cells and superincumbent gums, in which they are confined. The constitution, at this tender period of life, often receives a shock from which it never recovers; and the seeds of many chronic diseases are caused to germinate, which, otherwise, in all probability, would have forever remained dormant.

This is generally regarded as the most critical period of life, and it has often proved one of bereavement and sorrow. The whole process is sometimes completed without inconvenience, but, at other times, it is attended with so much pain and irritation that the most alarming and complicated forms of disease result from it.

The irritation accompanying first dentition is supposed to be caused by the pressure which the teeth make upon the gums in forcing their way out, which irritation varies in extent, according to the health and temperament of the child. When the absorption of the gums and dilatation of the neck of the sac keep pace with the growth of the tòoth, the pressure is scarcely perceptible; but when these functions are tardily performed it becomes more or less great, in proportion as the growth of the one outstrips the absorption and dilatation of the other. It may be, that much of the irritation is produced by the pressure of the tooth upon the pulp; for, when its progress is retarded by the resistance of the gums, the elongation of this, for the formation of the root, would, of necessity, cause the solidified part to press upon it; which as a matter of course, would give rise to great pain and irritation.

Dr. Good is of opinion that the pressure of the teeth against the gums "is not uniformly exerted throughout the course of teething, but is divided into distinct periods or stages; as though the vital or instinctive principle, which is what we mean by nature, becomes exhausted by a certain extent of action, and requires rest and a state of intermission.

"The first or active stage of teething is usually about the third or fourth month of infancy, and constitutes what is called breeding the teeth; or the conversion of the pulpy rudiment buried in the gums and formed during fœtal life, into a solid material, which, at the same time, shoots downward, and gives to every tooth a neck or fang."

The period of dentition here referred to is the time when the sac begins to contract. The coronal extremity of the tooth is then brought in contact with the sac, and when the formation of the root of the former proceeds more rapidly than the contraction of the latter, the root comes in contact with the bottom of the alveolus, and doubtless much of the irritation, as we have before intimated, resulting from dentition, is attributable to this circumstance. But Dr. G. is mistaken in supposing that the pulpy rudiment begins to be converted into a solid material at the third or fourth month of infancy, when, what he terms, the first or active stage of teething commences. Several layers of dentine are perfectly formed over most of the pulps of the temporary teeth at birth, though the enamel is not quite completed at so early a period. The doctor has evidently confounded the commencement of the elongation of the pulp with that of its solidification.

During the period of teething, the child is restless and fretful, but its paroxysms of suffering are periodical, and seldom last more than two or three hours at a time; whereas, were the pressure of the teeth upon the gums uniform and constant, there would be no intermissions. The repose thus afforded, enables the system to recover in some degree from the exhaustion occasioned by each preceding paroxysm. If it were not for this, its excited energies would soon be worn out, and the child fall a victim to the continued intensity of its sufferings.

When the irritation is merely local, it is usually of short duration, and consists in a slight tenderness and tumefaction of the gums, accompanied by increased secretion of saliva. But when it is sufficiently great to affect the functional operations of other parts of the system, febrile symptoms of a general and more or less aggravated character supervene, attended with drowsiness, diarrhœa, and not unfrequently, with various cutaneous eruptions; such as the red gum, also pustules, at first filled with limpid fluid,

but which, afterwards, become purulent. The former appear on the neck and face: the latter are not confined to any particular part of the body, but are either thinly scattered over its whole surface, or appear in small patches. There is also another kind of eruption which breaks out about the mouth, cheeks and forehead, sometimes extending to the scalp; which, in a short time dries up and becomes covered with disagreeable scabs. These drop off, after a while, to be succeeded by others.

These eruptions are generally regarded as indications of the substitution of a milder for a more aggravated form of disease, and should not, therefore, be too hastily suppressed.

To these symptoms, we may add, cough, spasms of the muscles of the face, particularly of those about the mouth; and, when the diarrhœa is so copious as to occasion great emaciation, convulsions and death, sometimes, supervene.

Thus far, we have merely glanced at a few of the effects of first dentition. To attempt a description of all, would involve the enumeration of the whole catalogue of diseases peculiar to infancy; but which, as they more properly belong to another branch of medicine, we shall neither stop to describe nor point out, minutely, their curative indications.

It may be well, however, to state, that the local treatment consists in making a free incision with a lancet through the tumefied gum, down to the advancing tooth. This, in very many cases, affords immediate relief and supersedes the necessity of other treatment. It is objected to by some, on the ground, that, though it may afford temporary relief, the cicatrix, formed by the healing of the wound, constitutes a greater obstacle to the exit of the tooth, than the parts ever do when left to themselves. Now, any one at all conversant with the subject, knows that in four cases out of five, where the operation is necessary, the teeth are so far advanced, that when the incised gums collapse, their crowns immediately protrude: and even when the wound does unite, the soft and spongy cicatrix yields more readily to the action of the absorbents than the gums do in their natural state.

Another objection is founded upon the supposition that the enamel, at this early period, is in a soft and amorphous state, and that, consequently, the teeth may be injured by the contact of the knife. But as the parts of the enamel exposed to the in-

strument usually attain their greatest hardness before such operation is required, this objection is without foundation. In short, we have never known any injury to result from it, either in our own practice, or in that of others: nor can those who are opposed to it, bring facts to support their opposition.

It is true, there is sometimes considerable hemorrhage, which, in two or three instances, has terminated fatally, but it rarely happens that this is very considerable, and it almost always subsides in a few minutes.

This simple operation often succeeds after all other attempts to afford relief have failed. We have frequently known children, after having suffered the greatest agony for days and weeks and until they had become reduced to mere skeletons, obtain immediate relief without any other treatment. This at once removes the cause; whereas, other remedies only counteract the effects of the suffering, and can only be considered as palliatives that may assist nature in her struggles with disease, but cannot always prevent her from sinking in the contest.

CHAPTER NINTH.

SHEDDING OF THE TEMPORARY TEETH.

Some very singular notions were entertained among the ancients concerning the temporary teeth. Many thought they never had roots, inasmuch as they were observed to be wanting when they dropped out; others, that the crowns were removed, while the roots remained and afterwards grew and became the permanent teeth.

The shedding of the temporary teeth, a most wonderful operation of the economy, is effected in accordance with an established law; but there exists, among physiologists, some difference of opinion with regard to the precise manner in which it is effected. Most writers ascribe their destruction to the action of the absorbents. Mr. Fox supposes, that as the new teeth begin to rise from their sockets, they come in contact with, and press upon, first, the partition of bone intervening between them and the roots of the temporaries, and afterwards upon the roots themselves; and this pressure, he believes, induces their absorption. He afterwards, however, admits that pressure is not necessary to their absorption, as it sometimes takes place where there is none.

Mr. Hunter does not attempt to explain the manner of the destruction of the roots of the temporary teeth in any other way than by stating, that they decay off up to the gum. Fauchard and Bourdet attribute their removal to the action of a corrosive fluid, supplied for the special purpose. Bunon thinks they are worn away by the rising teeth. Lecluse is of the opinion that when the process of their removal begins, their vessels cease to supply nourishing juices, and that they are broken up by a species of maceration; while Jourdain thinks it is both by abrasion and corrosion.

Mr. Bell, as do indeed almost all recent writers, adopts the theory of Mr. Fox, that the destruction of the roots of the temporary teeth is the result of absorption. Laforgue, observing a

fungiform or carneous substance behind the root of the temporary tooth—which, in fact, had been noticed by Bourdet, and supposed by him to exhale a fluid possessed of solvent qualities—gave it the name of absorbing apparatus, and assigned to it the office of removing the root of the primary tooth.

Delabarre, who has treated this subject at greater length and, apparently, investigated it more closely, corroborates the views of Laforgue, and gives the following description of the manner of the formation and function of the carneous substance spoken of by this author. "While the crown of the tooth of replacement," says Delabarre, "is yet in formation, the external membrane of the matrix is simply crossed by a few blood-vessels; but as soon as it is completed, the capillaries are then developed in a very peculiar manner, and form a tissue as fine as cobweb; from this tissue the internal membrane, instead of continuing very delicate, and of a pale red color, increases in thickness and assumes a redder hue. As was before said, it is at the instant in which the contraction of the coats of the matrix commences, (investments which extend from the gum to the neck of the tooth), that the congeries of vessels entering into their tisssue, assist in forming a body of a carneous appearance, whose absorbents extend their influence over all the surrounding parts; it is, therefore, the dental matrix itself, which, after being dilated to serve as a protecting envelop to the tooth, is contracted to form—not only this bud-like body which we find immediately below the milk tooth at the instant in which it naturally falls out, and whose volume is necessarily augmented as odontoscisis gradually goes on; but also a carneous mass by which the whole is surrounded, and whose thickness is the more remarkable as the organ that it envelops is nearer its orifice."

After giving this description, he asks, "Is there a dissolving fluid that acts chemically on the surrounding parts; or do the absorbents, without any intermediate agency, destroy everything that would obstruct the advance of the tooth?" In reply to this, he says, "Not possessing positive proof to guide me in the decision of these questions, and finding the evidence of others of little importance, I shall not attempt to answer them."

In pursuing this subject further, he states that the vessels of the temporary tooth often remain entire in the midst of this car-

neous (fleshy) substance, and continue to convey their fluids to the central parts, whilst the calcareous ingredients and the gelatine have been removed; but that, at other times, they too, are destroyed. The conclusion to which he arrives, after a careful examination of the whole subject, is; that whether the earthy and animal parts of the roots are removed by the absorbents of the carneous tubercle in question without previous change, or whether they are decomposed by the chemical action of a fluid exhaled from it, they are ultimately carried back into the general circulating system.

In proof of the agency of the carneous tubercle in the destruction of the roots of the temporary teeth, he mentions one fact that goes very far to establish the truth of the opinion that it does so; and which, if his views be correct, will account for those cases occasionally to be met with, in which one or more of the permanent teeth fail to appear. It is this: if the carneous substance fails to be developed, or is destroyed, the successional tooth remains in its socket, and never makes its appearance. Cases of this kind have fallen under the notice of almost every dentist.

In as few words as possible we have given the views of this ingenious writer on the subject under consideration; and although they do not seem to have attracted much attention from English writers, and are rejected by Mr. Bell on the ground, that the destruction of the root of the temporary tooth frequently commences on a part "the most remote from the sac of the permanent tooth," we are disposed to believe them, for the most part, correct, the more especially since we entirely disagree with Mr. Bell. As to the existence of the fleshy tubercles, there can be no question, and that it is through the agency of these that the roots of the temporary teeth are destroyed, seems more than probable. But, whether it is through the agency of their absorbent vessels or a chemical fluid exhaled for the purpose, may not, as Delabarre says, be so easy to determine. We are inclined to believe, however, that the latter agent is the one principally concerned in effecting the destruction of the fangs, and for the reason that if litmus paper be applied to the fleshy tubercle, immediately after the crown of a temporary tooth has fallen out or been removed, it turns red, thus showing the presence of an

acid. That the absorbents have something to do in this process, is, we think, very probable; but we believe the operation of these delicate vessels is here always preceded by the action of a chemical agent.

The change that takes place in the external membrane of the sac, as noticed by Delabarre, is observable, first, on the peduncle or chord leading from it to the gum behind the temporary tooth. It here becomes thickened about the time that the root of the new tooth begins to form, and assumes a fleshy appearance, and it is here that the destruction of the surrounding bone commences, enlarging the alveolo-dental canal, and gradually removing the intervening bony partition, and finally, the root of the temporary tooth. The agency of this thickened and fleshy condition of the external membrane of the capsule in the removal of the roots of the temporary teeth is rendered more conclusive by the fact, that, in those cases in which the roots of the permanent teeth have become partially destroyed, the alveolo-dental periosteum presents a similar appearance. In the formation, too, of alveolar abscess, the tubercle at the extremity of the root presents a like aspect. There also seems to be, in this interesting operation of the economy, an association of functions mutually dependent upon each other; so that, if one be suspended, the others fail to be performed. Thus, if from any cause, the sac fails to contract, the fleshy tubercle is not developed, nor does the formation of the root take place; consequently, the crown of the tooth remains in its alveolus. Harmonious consent of associated actions are nowhere more beautifully exemplified, than in these three operations.

It often happens, that the root of a temporary tooth fails to be destroyed, and that the crown of the replacing organ comes through the gum in a wrong place. Whenever this occurs, the carneous body is developed only beneath the parts through the opening of which the new tooth has appeared, and is not brought in contact with the bony partition, between it and the root of the temporary tooth.

The manner of the destruction of the roots of the temporary teeth has been a subject of careful inquiry with the author for several years; and the more he has examined it, the more fully has he become convinced, that it is the result of the action of

this fleshy tubercle. While its formation would seem to be the result of the contraction of the dental sac and its appendage, for the purpose of effecting the eruption of the tooth, it is especially charged with the removal of everything that would obstruct its passage.

In conclusion, it is only necessary to observe that the temporary teeth are shed in the same order in which they appear. After one pair has been shed, a sufficient time usually elapses before the shedding of another, for those of the same class of the permanent set to come forward and take their place. Thus, the jaws are never deprived, unless from some other cause than the destruction of the roots of the temporary set, of more than two teeth in each jaw at any one time.

CHAPTER TENTH.

SECOND DENTITION.

There are no operations of the animal economy more singular or interesting than those exhibited in the gradual destruction of the roots of the temporary, and in the growth and eruption of the permanent teeth. The time of life when they occur, constitutes an important epoch in the history of every individual.

During childhood, the alveolar arches form only about half a circle, but by the gradual elongation of the jaws they ultimately, at adult age, form nearly the half of an ellipsis; so that the number of teeth required to fill them at the one period, is but little more than half the number required at the other.

Moreover, the food of children is principally vegetable, requiring but little mastication to prepare it for the stomach; whereas, that of adults consists of an almost equal additional portion of animal matter, which, owing to the greater cohesion of its particles, require a more numerous and substantial set of instruments for its trituration.

So admirable is the economy of second dentition, that even before the shedding of the temporary teeth commences, and as soon as the jaws are sufficiently enlarged, four of the second set, one on each side, in each maxilla, make their appearance. Consequently, the number of teeth, after the completion of the first set, is never diminished, unless by accident or disease.

The rudiments of the permanent incisors and cuspids have attained their full size at birth, and each is situated immediately behind its corresponding temporary tooth.

The permanent teeth, with the exception of the bicuspids, are considerably larger than the temporary, and during the time of their formation are situated in the segment of a much smaller parabola. But before the shedding of the first set begins, the successional teeth, by an increase in the depth of the jaws, and the development of the alveolar processes, are brought forward:

and, at about the fifth year, they are situated immediately beneath the deciduous in the lower, and nearly above them in the upper maxilla, occupying places in the alveolar border, corresponding in depth to the length of their respective roots.

By this arrangement the permanent teeth occupy the smallest possible space in the jaws. The central incisors and cuspids nearly fill the anterior part of the arch, while the lateral are thrown behind and partly between them.

The following concise description of the relative position of the teeth, at the fifth year after birth, is given by Mr. Bell. "In the upper jaw, the central incisors are situated immediately beneath the nose, the lateral incisors are thrown back behind the points of the cuspids, and the base of the latter is scarcely a quarter of an inch below the orbit. In the lower jaw, the cuspids are placed at the very base of the bone, with only a thin layer beneath them, but the crowding is much less considerable than in the upper jaw, from the smaller comparative size of the incisors.

"The permanent central incisor of the lower jaw is placed immediately beneath the temporary, with its point directed a little backwards, behind the partially absorbed root of the latter. The lateral incisor, not yet so far advanced, is placed deeper in the jaw, and instead of being immediately beneath the temporary, is situated with its point between the roots of this and the cuspid. The permanent cuspid is still very deeply imbedded in the bone, with its point resting between the roots of the temporary cuspid and the first temporary molar. The two spreading roots of the latter encompass, as it were, within their span, the first bicuspid; and those of the second temporary molar, in like manner, grasp the second bicuspid. Nearly a similar arrangement is found to exist in the upper jaw, except that the teeth are altogether more crowded."

In Fig. 52 is exhibited a front and side view of the superior and inferior maxillary bones, with the temporary teeth *in situ*, the outer wall of the alveolar border being removed, shows the situation of the crowns of the permanent incisors, cuspids, bicuspids and first molars.

The irritation consequent upon the eruption of the permanent teeth, is usually very slight, and with the exception of the dentes

sapientiæ, seldom occasions much inconvenience. This is owing to the fact, that when second dentition commences, the system has acquired so much vigor and strength, as not to be easily affected by slight morbid impressions; and the gums offer, comparatively, little resistance to the eruption of the teeth of replacement, for when the temporaries drop out, the others are generally so far advanced as to appear almost immediately. Even when this is not the case, the cicatrix that forms over the permanent tooth is of so spongy a texture that it readily yields to the action of the absorbents. The process, too, is more gradual, from six to eight years being required for its completion, while the eruption of the teeth of first dentition is accomplished in less than half that time.

Fig. 52.

Fig. 52. A view of the superior and inferior maxillary bones of a child about four years old, with their exterior and outer walls removed, so as to show the crowns of the permanent teeth behind the roots of the temporary. The superior maxillary bones are separated at the median line, and about a quarter of an inch apart. Behind the second temporary, are seen the crowns of the first permanent teeth imbedded in the alveolar ridge.

Second dentition usually commences about six or seven years after birth, and is generally completed, as far back as the second molars, by the twelfth or fourteenth year. The dentes sapientiæ seldom appear before the eighteenth or twentieth year. The periods for the eruption of the adult teeth are, however, so variable, that it is impossible to state them with perfect accuracy. Sometimes the first permanent molars appear at four years, and the central incisors at five; at other times, these teeth do not appear before the ninth or tenth year.

But as it is of some importance that the periods of the eruption of the several classes of the permanent teeth should be known, we will state them with as much accuracy as possible.

First molars,	from . . .	5 to 6 years.
Central incisors,	" . . .	6 to 8 "
Lateral incisors,	" . . .	7 to 9 "
First bicuspids,	" . . .	9 to 10 "
Second bicuspids,	" . . .	10 to 11½ "
Cuspids,	" . . .	11 to 12 "
Second molars,	" . . .	12 to 14 "
Third molars, (dentes sapientiæ,)	.	17 to 21 "

But, as before stated, the periods for the eruption of the permanent teeth, like those of the temporary, are exceedingly variable. The cuspids often appear before the second bicuspids, and in some cases, the dentes sapientiæ not until the thirtieth or even fortieth year, and sometimes they never show themselves.

The author is acquainted with a gentleman who did not shed his left superior cuspid until he was twenty. A few months after, the permanent cuspid made its appearance. In fact, he has known the temporary cuspids in several instances to remain until the fortieth year, but when shed at this late age they are rarely replaced. In the *General Archives of Medicine* for June, 1840, the case of a woman is recorded, who, at the age of forty-three, acquired four permanent incisors, behind the temporary, which, up to this period, had not been shed. Four molars made their appearance a year later; and M. Desirabode says he has met with similar cases.

Maury fixes the period for the eruption of the four first molars at from six to eight years, and Desirabode at from six to seven, but we have rarely known them to delay their appearance beyond the sixth year. Both of these authors, too, place the cuspids, in the order of the eruption of the teeth, before the second bicuspids.

ACCRETION OF THE JAWS.

As the rudiments of the temporary teeth increase in size, a corresponding increase in the maxillary bones takes place, but during the earlier stages of the formation of the permanent teeth their growth is not so manifest. At about two and a half years after birth, they begin to elongate, and generally, at the fifth year, have acquired sufficient length to admit behind the second temporary, the first permanent molars. After the completion of first dentition, the part of the alveolar border occupied by this set of teeth, augment in dimensions but very little. The increase, after this time, is chiefly confined to the back part of the jaw, between the second temporary molars and the coronoid processes in the lower, and the maxillary tuberosities in the upper. The anterior part of the jaws do, however, augment a little, although so inconsiderable is the increase here,

that some, and among whom are Hunter and Fox, have been induced to deny the fact. By the admeasurement of various jaws, at different ages, the writers just named have endeavored to prove, that the superiority in size of the permanent over the temporary incisors is not greater than the difference existing between the temporary molars and the bicuspids to the advantage of the former, and that, consequently, no increase in this part of the jaw is necessary. But a measurement of the same jaw, made after the first permanent molars have come through the gums, then again after the eruption of all the teeth of replacement, will show that their measurements are not to be relied on.

M. Delabarre, in attempting to prove the incorrectness of these gentlemen's calculations, by a similar course of experiments, appears to have fallen into an opposite error; whence, it would seem, as is justly remarked by Mr. Bell, "that no comparison, instituted between the jaws of different individuals, can be relied on as conclusive." The only way by which we can arrive at the truth of the matter is by examining the same jaw at different ages, and comparing the several results. "This," says Mr. B., "I have repeatedly done, and have no hesitation in saying, that the ten anterior permanent teeth occupy a somewhat larger arch than the temporary ones which preceded them had done."

The transverse and perpendicular dimensions of the anterior part of the jaws continue to augment until the completion of second dentition.

In alluding to the influence which the pressure of the teeth has in determining an increase of the anterior part of the jaws, Delabarre contends, that while any immediate pressure of these organs is impossible except at the time when they are forcing their way through the enlarged alveola-dental canals, their contact, at this period, gives rise to a mechanical increase; and he believes that, previously to this period, the enlargement is carried on by the liquor contained in the dental sacs. He argues, therefore, that the jaws, besides the mode of accretion resulting from nutrition, "have another, peculiar to themselves," coinciding with the development of the dental sacs, and the quantity of fluid which they contain; as also with the manner of the arrangement of the crowns of the permanent teeth between such as may be in the circle, whether belonging to first or second dentition.

That the dimensions of the alveolar arch may be increased by pressure upon the teeth from behind forward, no one will deny; but to suppose the accretion of the jaws may be determined by the pressure of these organs against each other, or by the fluid contained in the dental sacs, would be to suppose that the law that determines growth in other bones, is inoperative here. In fact, to do this, would be attributing it rather to accident than to a natural operation of the economy.*

The elongation of the jaws produce a corresponding change in the form of the face. Thus, the face of a child is round, that of an adult is long and prominent.

The permanent incisors usually fill the space formerly occupied by the temporaries of the same class, and about one-half of that previously filled by the primitive cuspids. The other half of this space, together with a moiety of that before taken up by the first temporary molars, is occupied by the permanent cuspids.

The bicuspids occupy spaces larger by one-fifth or sixth than those occupied by the remaining moiety of the first, and the whole of the second temporary molar.

Hence, it will be perceived that the ten anterior permanent teeth occupy a somewhat larger space than that taken up by the temporary ones which preceded them, and that, were there no increase in the size of this portion of the arch, the regularity of their arrangement would be more or less disturbed. To prevent this a slight increase is necessary, but the dimensions of that portion of the alveolar border occupied by the temporary teeth is not materially increased until these teeth are shed, and then, as those of replacement come forward to take their place, they arrange themselves in a somewhat larger arch. It is in this manner that the size of the alveolar border is augmented.

* The formation of the alveolar processes, and that of the teeth, take place according to different laws. The jaws grow and enlarge in conformity with the general laws which preside over the increase of the osseous system. The alveolar arches, at birth, are little more than one inch in length; at nine years of age, they are nearly two inches, and at the period of perfect growth, at least two inches and a half long. The depth of the lower jaw in the fetus at the full time is one-seventh, and in the adult one-fifth of the whole weight of the head. The teeth, on the contrary, uniformly appear with the breadth and thickness only, not the length, to which they will ever attain. In order that the development of these organs may take place in a regular manner, it is, therefore, necessary that a certain harmony be established between their sizes at different periods, and the alveolar ridges of the jaws.—*Bourgery's Anatomy.*

In fact, a new alveolar ridge is formed, and this last is slightly larger than the first.

But there is not always an increase in the anterior part of the jaws; on the contrary, the premature loss of one or more of the temporary teeth often occasions a contraction that frequently causes irregularity of the permanent set, and sometimes forces the first and second molars so far back that the dentes sapientiæ are thrown against the coronoid processes; and thus, in many instances, producing such severe inflammation in the muscles of this portion of the jaw, that the extraction of these latter teeth is rendered absolutely necessary.

About the third year, the jaws are more rapidly elongated, in order that the first permanent molars, which are at this time slowly advancing, may find room behind the second temporary molars. This elongation continues until the dental arches have become sufficiently enlarged for the reception of the whole of the permanent teeth.

It sometimes happens that the jaws in their accretion are badly developed, and have a faulty configuration. This may occur with one or both jaws. The alveolar arch is sometimes too narrow, having a compressed appearance, and projecting so far forward as to prevent the upper lip from covering the front teeth, thus imparting to the individual an exceedingly disagreeable appearance. In cases of this sort, the roof of the mouth, instead of having an oval arch, presents an irregular triangle. At other times the alveolar arch is too wide, so that the teeth are separated from each other, giving to the roof of the mouth a flattened aspect.

Similar defects are met with in the configuration of the lower jaw. Its sides may be too close together, causing the front teeth to project, and to cross and strike on the outside of the upper incisors, or it may describe too large a circle.

These defects are regarded as hereditary, and are more peculiar to some nations than others. The tendency to them is observable in early childhood, and even in infancy. Many suppose they are determined by a rickety diathesis; but this opinion has been proven to be incorrect by the fact, that those affected with this disease generally have good palates and well developed jaws. So far, indeed, from its having any agency in their pro-

duction, rickets is thought by some to be produced by dentition. The reason assigned for this belief, is its frequent occurrence at the period of life when this process is going on; but this opinion is doubtless as incorrect as is the other and opposite one. These peculiarities in the formation of the jaws no doubt often result as a consequence of the intermarriage of the people of one nation with those of another, or of near blood relations with one another. The upper jaw will resemble in shape and size that of the father, and the lower that of the mother, or vice versa; or deformity may be present in both jaws.

There is a species of deformity in the upper jaw, the cause of which is equally difficult of explanation, charactérized by one or more divisions of the upper lip, alveolar ridge and palatine arch, and necessarily accompanied by irregularity in the arrangement of the teeth. This deformity, depending on the arrest of growth in the originally separated, embryonic, incisive tubercles (inter-maxillary bones), super-maxillary and palate bones, is always congenital, and often exceedingly difficult to remedy.

Any infringement of the laws of growth, or disturbance of the functional operations of any of the organs of the face or head, may, we have no doubt, determine an improper development of the jaws and a bad arrangement of the teeth; on the other hand, a perfect, correct and healthful performance of the several functions of all the parts concerned in the formation and growth of this portion of the organism, will secure a natural development and configuration of the maxillary bones.

CHAPTER ELEVENTH.

METHOD OF DIRECTING SECOND DENTITION.

There is nothing more destruetive to the beauty, health and durability of the teeth, and no disturbanee more easily prevented, than irregularity of their arrangement. Also, in proportion to the deviation of these organs from their proper position in the alveolar areh, are the features of the faee and the expression of the countenance injured. It also inereases the suseeptibility of the gums and alveolo-dental membranes to morbid impressions.

It is important, therefore, that the mouth during second dentition, should be properly cared for ; and so thoroughly eonvinced is the author of this, that he does not hesitate to say, that if timely precautions were used, there would not be one decayed tooth where there are now a dozen.

Mueh harm, it is trne, may be done by improper meddling with the teeth during this period, but this so far from inducing a total negleet, should only make those having the eare of ehildren more solieitous in seeuring the serviees of seientifie, aeeomplished praetitioners.

For the judicious management of seeond dentition, mueh judgment and a eorreet knowledge of the normal periods of the eruption of the several classes of teeth, are required. All uneeessary interference with these organs, at this early period of life, should certainly be avoided, as it will only tend to mar the perfeetion at which nature ever aims. The legitimate duty of the physician being, as Mr. Bell eorreetly observes, "the regulation of the natural funetions when deranged," he should never anticipate the removal by nature, of the temporary teeth, unless their extraetion is called for by some pressing emergeney, such as, a deviation of the permanent ones from their proper place, alveolar abscess, or exfoliation of the alveolar processes.

Among the few who have treated this subjeet in a full and philosophieal manner, we will mention Delabarre, whose work

contains more explicit directions in regard to it than any which has as yet appeared. Owing to the superficial manner in which second dentition is frequently studied, this author was led to remark, "that the laws which govern the expansion, growth and arrangement of the teeth, are properly the patrimony of the physician, who should understand them, in order to direct the dentist, whenever (which unfortunately is very frequently the case) he is not furnished with sufficient information on all the duties of his profession." That this was necessary at the time Delabarre wrote, cannot be doubted; but at present we have many men in the dental profession better qualified to judge of what is required in cases of this sort, than any general practitioner whose attention has never been specially directed to this peculiar department of practice.

The mouth should be frequently examined from the time the shedding of the deciduous teeth commences until the completion of second dentition; and when the growth of the permanent teeth so far outstrips the destruction of the roots of the temporary that the former are caused to take an improper direction, such of the latter as have occasioned the obstruction, should be immediately removed. In the dentition of the upper front teeth, this should never be neglected; for, when they come out behind the temporaries, as they most frequently do, and are permitted to advance so far as to fall on the inside of the lower incisors, a permanent obstacle is offered to their subsequent proper adjustment.

When a wrong direction has been given to the growth of the lower front teeth, they are rarely prevented from acquiring their proper arrangement by an obstruction of this sort. They should not, however, on this account, be permitted to occupy an erroneous position too long; for the evil will be found easier of correction while recent, than after it has continued for a considerable length of time. The irregularity should be immediately removed.

The permanent central incisors of the upper jaw being larger than the temporaries of the same class, it might, therefore, be supposed, that the aperture formed by the removal of the one, would not be sufficient for the admission of the other, without an increase in the size of this part of the maxillary arch. It should be recollected, however, that by the time these teeth usually emerge from the gums, the crowns of the temporary lateral in-

cisors are so much loosened by the partial destruction of their roots, as to yield sufficiently to the pressure of the former, to permit them to take their proper position within the dental circle. When this does not happen, the temporary laterals should be extracted.

Under similar circumstances, the same course should be pursued with the permanent lateral incisors and the temporary cuspids, and also with the permanent cuspids and the first bicuspids.

The bicuspids being situated between the fangs of the temporary molars, are seldom caused to take an improper direction in their growth. Nor are they often prevented from coming out in their proper place for want of room.

In the management of second dentition, much will depend on the experience and judgment of the practitioner. If he be properly informed upon the subject, and gives to it the necessary care and attention, the mouth will, in most instances, be furnished with a healthful, well arranged and beautiful set of teeth. At this time, "an opportunity," says Mr. Fox, "presents itself for effecting this desirable object," (the prevention of irregularity,) "but every thing depends upon a correct knowledge of the time when a tooth requires to be extracted, and also of the particular tooth, for often more injury is occasioned by the removal of a tooth too early than if it be left a little too long; because a new tooth, which has too much room long before it is required, will sometimes take a direction more difficult to alter, than a slight irregularity occasioned by an obstruction of short duration."

Mr. Bell objects to the extraction of the temporary teeth, especially in the lower jaw, to make room for the permanent, on the ground that the practice is harsh and unnatural—that it often gives rise to a contraction of the maxillary arch, and that, in consequence of the peduncular connection which exists between the necks of the temporary teeth and the sacs of the permanent ones, it interferes with the uniform deposition of the enamel.

These objections, if they were well founded, should deter every dentist from adopting the practice; except as a dernier resort, as the lesser of two evils. But when the temporary teeth, by remaining too long, are likely to affect the arrangement, and, consequently, the health of the permanent teeth, they should be

extracted; because, in that case, their presence is a greater evil than any that would be occasioned by their removal. As a general rule, they should be suffered to remain until their presence is likely to injure the permanent teeth and their contiguous parts. The last objection is founded upon a false assumption, but on other grounds it may often be very properly urged.

When the permanent teeth are crowded, the lateral pressure is frequently so great as to fracture the enamel. If this cannot be prevented in any other way, one on each side should be extracted. It is better to sacrifice two than permanently to endanger the health of the whole.

M. Delabarre, in cases where the crowding is not very great, recommends passing a file between the teeth, as does also Mr. Bell, when only the space usually occupied by half of a tooth is required.

Notwithstanding the deservedly high authority of these two gentlemen, the author's experience compels him to condemn the latter practice. The apertures thus formed soon close, but not so perfectly as to prevent small particles of extraneous matter from lodging between the teeth, and being retained there until they become putrid, vitiating the mucous and salivary secretions of the mouth, and thus causing the teeth to decay. In this manner, he has sometimes known the front teeth to be entirely destroyed; and he has always observed, that teeth which had been thus filed, were invariably the first, and sometimes the only ones, to decay—thus clearly pointing out the pernicious tendency of the practice.

He does not, however, wish to be understood as conveying the idea that filing the teeth necessarily causes them to decay, for, when the file is used for any other purpose than to gain room, the apertures may be made large enough to prevent the approximation of the organs, and thus the bad effects resulting from the operation will be prevented.

The file should never be used, therefore, with a view to remedy irregularity; the extraction of two teeth, one on each side of the jaw, however small the space required to be gained may be, is far preferable. The second bicuspids, *cæteris paribus*, should always be removed rather than the first, but sometimes the extraction of the first becomes necessary.

By the removal of two teeth, ample room will be gained for the arrangement of all the remaining ones, and the injury resulting from a crowded condition of the organs prevented.

On filing teeth, to prevent irregularity, Dr. Fitch judiciously remarks: "I consider the expediency of filing or not filing the teeth, ought to be a subject of serious deliberation on the part of the dental practitioner, never, especially in young persons, performing the operation, unless obliged to do so, to cure actual disease. I was greatly surprised, therefore, in the late work of Mr. Bell, to see directions to file slightly irregular and crooked teeth, so as to gain the room of about half a tooth."

Nature, when permitted to proceed with her work without interruption, is able to perform her operations in a perfect and harmonious manner. But the functional operations of all the parts of the body are liable to be disturbed from an almost innumerable number and variety of causes, and impairment of one organ often gives rise to derangement of the whole organism. For the relief of which, the interposition of art not unfrequently becomes necessary, and it is fortunate for the well being of man, that it can, in so many instances, be applied with success.

In sound and healthy constitutions, the services of the dentist are seldom required to assist or direct second dentition. In remarking upon this subject, Dr. Koecker observes, "that the children, for whom the assistance of the dentist is most frequently sought, are those who are either in a delicate, or at least in imperfect constitutional health; in whom the state not only of the temporary teeth, but of the permanent also, is to be considered; and, where both are found diseased, the future health and regularity of the latter require the greatest consideration of the surgeon.

"Irregularity of the teeth is one of their chief predisposing causes of disease, and never fails, even in the most healthy constitutions, to destroy, sooner or later, the strongest and best set of teeth, unless properly attended to. It is thus not only a most powerful cause of destruction to the health and beauty of the teeth, but also to the regularity and pleasing symmetry of the features of the face; always producing, though slowly and gradually, some irregularity, and not unfrequently the most surprising and disgusting appearance."

Finally, we would remark, that though nature is generally able to accomplish the task assigned her; yet there are times when she requires aid, and it is then, and then only, that the services of the dentist are needed. Therefore, whilst, on the one hand, we should guard against any uncalled for interference, we should, on the other, always be ready to give such assistance, as the nature of the disturbance presented to our notice, may require.

CHAPTER TWELFTH.

IRREGULARITY OF THE TEETH.

THE temporary teeth seldom deviate from their proper place in the alveolar arch; but irregularity of arrangement is of frequent occurrence in the permanent teeth, especially the cuspids and incisors. The first and second molars are seldom irregular; for, like the teeth of first dentition, they rarely encounter obstruction in their growth and eruption. The first molars being the first of the permanent set to appear, the ten anterior teeth are limited to that part of the arch occupied by the ten milk teeth: if this space is too small, irregularity must of necessity ensue.

The dentes sapientiæ are sometimes irregularly erupted in consequence of a want of correspondence between the developement of the tooth and the growth of the maxilla. The tooth in such case takes usually the direction of least resistance, the crown presenting more or less obliquely forward, backward, outward or inward. Of these four positions, the first and fourth are found usually in the lower jaw; the second and third are most common in the upper jaw.

When a bicuspid is forced from its proper place, it turns inward toward the tongue, or outward toward the cheek, accordingly as it is in the upper or lower jaw. The cuspids, when prevented from coming out in their proper place, make their appearance either before or behind the other teeth. When they come out anteriorly, which they do more frequently than posteriorly, they often become a source of annoyance to the upper lip, excoriating and sometimes ulcerating the mucous membrane.

The incisors of the upper jaw present a greater variety of abnormal arrangement than any of the other teeth. The centrals come out sometimes before and sometimes behind the arch; at other times, their median sides are turned either directly or obliquely forward towards the lip. The laterals sometimes appear half an inch behind the arch, looking towards the roof of

the mouth; at other times, they come out in front of the arch, and at other times again, they are turned obliquely or transversely across it.

When any of the upper incisors are very much inclined toward the interior of the mouth, the lower teeth, at each occlusion of the jaws, shut before them, and become an obstacle to their adjustment. This is a difficult kind of irregularity to remedy, and often interferes with the lateral motions of the jaw.

The lower incisors sometimes shut in this manner even when there is no inward deviation of the upper teeth. In this case, the irregularity is owing to preternatural elongation of the lower jaw, which arises more frequently from some fault of dentition, than from any congenital defect in the jaw itself.

Sometimes, the superior maxillary arch is so much contracted, and the front teeth in consequence so prominent, that the upper lip is prevented from covering them. Cases of this kind, however, are rarely met with; but when they do occur, it occasions much deformity of the face, and forms a species of irregularity very difficult to correct. From the same cause, the lateral incisors are sometimes forced from the arch, and appear behind the centrals and cuspids, the dental circle being filled with the other teeth.

There are many other deviations in the arrangement of the incisors. Mr. Fox mentions one that was caused by the presence of two supernumerary teeth of a conical form, situated partly behind and partly between the central incisors, which, in consequence, were thrown forward, while the laterals were placed in a line with the supernumeraries. The central incisors, though half an inch apart, formed one row, and the laterals and supernumeraries, another. Mr. Fox says he has seen three cases of this kind. This description of irregularity is rarely met with.

M. Delabarre says, that cases of a transposition of the germs of the teeth occasionally occur; so that a lateral incisor takes the place of a central, and a central the place of the lateral. A similar transposition of a cuspid and lateral incisor is, also, sometimes seen. Two cases of this sort have fallen under the observation of the author.

The incisors of the lower jaw, being smaller than those of the upper, and in other respects less conspicuous, do not so plainly

show an irregularity in their arrangement, nor is the appearance of an individual so much affected by it. Still it should be guarded against, for such deviation, whether in the upper or lower jaw, may prove injurious to the health of the teeth, and to the beauty of the mouth. The growth of the inferior permanent incisors is sometimes more rapid than the destruction of the roots of the corresponding temporaries. In this case, the former emerge from the gums behind the latter, and sometimes so far back as greatly to annoy the tongue and interfere with enunciation. At other times, the permanent centrals are prevented from assuming their proper place, because the space left for them by the temporaries is not sufficient. The irregularity in the former of these two cases, is greater than in the latter. The same causes, in like manner, affect the laterals.

M. Delabarre mentions a defect in the natural conformation of the jaws, by which the upper temporary incisors on one side of the median line are thrown on the outside of the lower teeth, while the corresponding teeth, on the other side of the same line, fall within.* The same arrangement, he says, may be expected, unless previously remedied in the permanent teeth. The author has met with but two cases of this sort, and the subjects of these he did not see until after they had reached maturity.

TREATMENT.

Orthodontia, or the treatment of irregularity, should accord with the indications of nature. When the irregularity is neither great nor complicated, and its causes are removed before the nineteenth or twentieth year, the teeth, without the aid of art, will, in most cases, assume their proper position. When, however, the efforts of the economy are unavailing, recourse should be had to the dentist, who can, in most instances, bring the deviating organs to their proper position in the arch. Teeth incline to return to their place on the removal of the cause of irregularity. They may be also made to change position under the influence of pressure. The pressure must be constant; it must be sufficient to cause motion, yet not so great as to set up destructive inflammation; lastly, it must be continued until the tooth can be kept in place by antagonism with the opposing

* *Traité de la Seconde Dentition*, p. 136.

teeth; or in case there is no such antagonism the regulating apparatus must be worn more or less constantly for a year, or even longer.

Teeth artificially regulated change position chiefly, if not entirely, by the double process of absorption from one side of the socket, followed by the slower process of ossific deposit on the opposite side. It is therefore essential to success that the tooth be retained in its new position, either by the other teeth, or by mechanical appliance, until such deposit is formed. Many cases fail from a want of persistence on the part of patient or dentist.

How far, and in what direction a tooth may be moved will depend partly upon the position of the apex of the root: partly upon the antagonism of the opposing teeth.

Cuspids growing out far up on the alveolar arch will usually be found to have short and curved roots. The attempt to move them might cause the curved apex to pierce the alveolus. Even when not curved, the fang is short and the regulated tooth will not possess that durability which is characteristic of the cuspids. It should always be borne in mind that in regulating teeth the crown is the movable point; whilst the apex of the fang is the fixed point, and must determine in great degree the extent and direction of motion.

Again, the natural or artificial movement of bicuspids backward to make room for front teeth, may be aided or hindered by the opposing teeth. An upper bicuspid, for instance, once carried back, so that the posterior slope of the lower bicuspid strikes it, will retain its position or may be thrown even farther back.

Upper incisors striking inside the lower, or lower incisors unnaturally prominent, may be regulated, and the opposing teeth will tend to keep them in their corrected position. But it will require long and patient use of the regulating apparatus to keep in place upper incisors, which project outward, or lower incisors inclining inward.

In deciding upon the removal or extraction of an irregular tooth, it should not be forgotten that a tooth moved by mechanical appliance, especially if the change in position is considerable, will not prove as durable as if no movement had been necessary. Hence it may sometimes be advisable to extract irregular cus-

pids in cases where their correction requires much change in their position and that of the bicuspids.

In a case very recently presented to Prof. Austen, the superior arch was perfectly regular and closely filled; but both cuspids had come out above the arch. The cuspid fangs were normal, and it seemed practicable to bring these teeth down into the places of the first bicuspids. But the four bicuspids were sound, and the first bicuspids gave very much the appearance of the natural arrangement. Hence, as in point of expression, there would be no great gain, and in point of durability, a probable loss, it was not thought advisable to subject the patient to the tedious annoyance of regulation.

The practicability of altering the position of a tooth, after the completion of its growth, was well known to many of the early practitioners. But before the commencement of the present century, the principal object of the dentist was, the insertion of artificial teeth; orthodontia, therefore, met with little attention. Fauchard and Bourdet were among the first to study this branch of dentistry. They invented a variety of fixtures for adjusting irregular teeth; but most of these were so awkward in their construction, and occasioned so much inconvenience to the patient, that they were seldom employed.

Mr. Fox was among the first to give explicit directions for remedying irregularity of the teeth, and his method of treatment has formed the basis of the established practice for more than fifty years. This long trial has proved it to be founded upon correct physiological principles, and much practical experience.

In describing the treatment of irregularity, we shall notice the means by which some of its principal varieties may be remedied; otherwise, the application of the principles of treatment would not be well understood, since it must be varied to suit each individual case.

As a general rule, the sooner irregularity in the arrangement of the teeth is remedied the better; for the longer a tooth is allowed to occupy a wrong position, the more difficult will be its adjustment. The position of a tooth may sometimes be altered, after the eighteenth, twentieth, or even the thirtieth year, but it is better not to delay the application of the proper means until so late a period. A change of this kind may be much more

easily effected before the several parts of the osseous system have reached their full development, and while the formative process is in vigorous operation, than at a later period of life. The age of the subject, therefore, should always govern the practitioner in forming an opinion as to the practicability of correcting irregularity. Previously to the twentieth year, the worst varieties of irregularity may, in most cases, be successfully treated.

The first thing claiming attention in the treatment, is the removal of its causes. Whenever, therefore, the presence of any of the temporary teeth has given a false direction to one or more of the permanent, they should be extracted, and the deviating teeth pressed several times a day with the finger, in the direction they are to be moved. This, if the irregularity has been occasioned by the presence of a deciduous tooth, will, generally, be all that is required.

But when it is the result of narrowness of the jaw, either natural or acquired, a permanent tooth on either side should be removed, to make room for such as are improperly situated. All the teeth being sound and well formed, the second bicuspids are the teeth which should be extracted; but if, as is often the case, the first permanent molars are so much decayed as to render their preservation impracticable, or, at least, doubtful, these teeth should be removed in their stead. After the removal of the second bicuspids, the first, usually, very soon fall back into the places which they occupied, and furnish ample room for the cuspids and incisors. But if they fail to do this, they may be gradually forced back by inserting wedges of wood or gum elastic between them and the cuspids, or by means of a ligature of silk, or gum elastic, securely fastened to the first molar on each side. These should be renewed every day, until the desired result is produced.

The most frequent kind of irregularity, resulting from narrowness of the jaw, is the prominence of the cuspids. These teeth, with the exception of the second and third molars, are the last of the teeth of second dentition to be erupted; consequently they are more liable to be forced out of the arch than any others, especially when it is so much contracted as to be almost entirely filled before they make their appearance. The common practice in such cases is to remove the projecting teeth.

But as the cuspids contribute more than any of the other teeth, except the incisors, to the beauty of the mouth, and can, in almost every case, be brought to their proper place, the practice is injudicious. Instead of removing these, a bicuspid should be extracted from each side. When the space between the lateral incisor and the first bicuspid is equal to one-half the width of the crown of the cuspid, the second bicuspid should be removed, but when it is less, the first should be taken out; because, although the crown of the latter may be carried far enough back after the removal of the former, to admit the crown of the cuspid between it and the lateral incisor, the root of this tooth will remain in front and partly across the root of the first bicuspid; leaving a more or less prominent vertical ridge on the anterior part of the alveolar border, which, to some extent at least, acts as an irritant to the gums and periosteum.

As the incisors of the upper jaw are more conspicuous than those of the lower, and when well arranged contribute more to the beauty of the mouth, their preservation and regularity are of greater relative importance. Hence, the removal of a lateral incisor, when it is situated behind the dental arch, as is often done with a view to remedy the deformity produced by false position, is a practice which cannot be too strongly deprecated, provided sufficient space can be made for it between the cuspid and central incisor, by the removal of a bicuspid from each side of the jaw.

In describing the treatment of irregularity, we shall commence with an incisor occupying an oblique or transverse position across the alveolar ridge; so that the cutting edge of the tooth, instead of being in a line with the arch, forms an angle with it of from forty to ninety degrees. This variety of deviation is rarely met with in both centrals, but often occurs with one. Some dentists have recommended in cases of this sort, when the space between the adjoining central and lateral incisor is equal to the width of the deviating tooth, to turn the latter in its socket with a pair of forceps, or to extract and immediately replace it in its proper position. It is scarcely necessary to say, that if a tooth is extracted or turned in its socket, the vessels and nerves from which it derives nourishment and vitality are severed; hence, though its connection with the alveolus may

be partially re-established, it will be liable to act as a morbid irritant, and be subject to inflammation from comparatively slight causes.

The tooth, however, may be brought to its proper position, without incurring the risk of injury, by accurately fitting a gold ring or band, with knobs on the labial and palatine sides; to each of these a ligature should be attached. Thus fastened to the ring, each end should be carried back, one on either side, in front and behind the arch, and secured to the bicuspids as represented in Fig. 53, so as to act constantly upon the irregular tooth. The ligatures should be renewed from day to day, until the tooth assumes its proper position. Should the space not be sufficient to permit the use of the band, the method practiced by Mr. Tomes, as shown in Fig. 54, will be found very effective. A plate is fitted to the inside of the arch, and a band carried in front and soldered to projections from the plate, which pass between the bicuspids. On each side of the twisted tooth a metallic dovetail is fastened and pieces of compressed wood inserted into them. The swelling of the wood gradually turns the tooth. In a few days the metal sockets will require to be changed in position, and in a few weeks the tooth may be thus brought nearly or quite to its natural place.

Fig. 53.

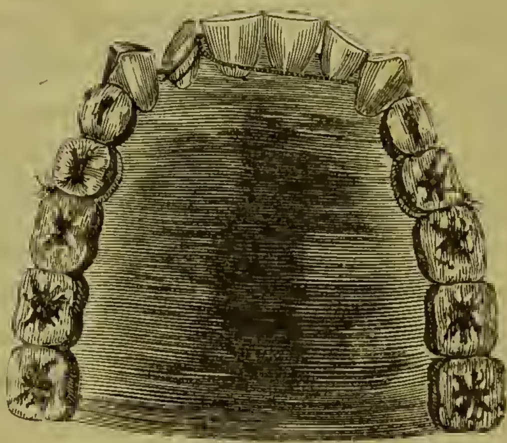
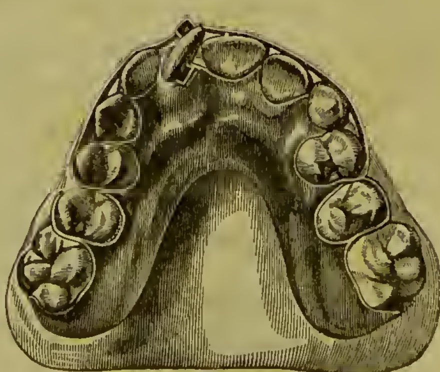


Fig. 54.



If the space permits, these two methods may be advantageously combined. Use the plate as in Fig. 54 with the inner dovetail; but for the long outside band substitute the band (Fig. 53) around the tooth, with a loop on the median side; from this

pass an elastic ligature to a hook soldered on the plate. The tooth is turned on its axis by the combined pull of the ligature and thrust of the wood.

Before attempting to turn the deviating organ, it should be ascertained if the aperture between the adjoining teeth is sufficient to admit of the operation. If not, it should be increased by the extraction of a bicuspid from each side of the jaw, and moving the teeth in front of them backwards until sufficient room is obtained. The time required to do this will vary from three to eight or ten weeks, depending upon the number of teeth to be acted on, and the age of the patient. A sufficient space may sometimes be gained by pressing outward the adjoining teeth in cases where they fall within the normal curve of the arch. This may be done by the expansion of wood or rubber, contained in metal sockets attached to the plate, behind each tooth to be moved.

Narrowness of the alveolar border is a frequent cause of irregularity of the upper incisors. In this case, the centrals usually project, though it sometimes happens that some are in front and some behind the arch, producing great deformity. To remedy which, the second bicuspids should be removed, unless the first molars are so much affected by caries as to render their preservation doubtful. In this case, they should be extracted, in place of the second bicuspids. If bicuspids and first molars are sound, and the decision turns upon the probable relative durability of the teeth, statistics decide very positively in favor of the bicuspids, especially under the age of fifteen. But the position of the first molar is too far back to permit, in all cases, the full benefit of the space gained by its extraction.

Fig. 55.

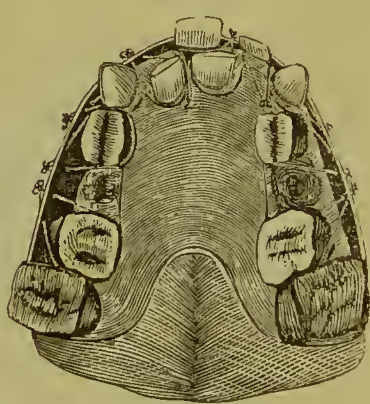
The following case will serve to illustrate the means employed for remedying this description of deformity. The subject was a young lady fifteen years of age. Her teeth presented the arrangement as seen in Fig. 55.

The second molars of the upper jaw occupied their proper position in the alveolar arch, or, in

other words, they were a little more than an inch and a quarter apart; the first molars were hardly an inch apart, and the first bicuspids were still nearer to each other. The cuspids, except that they were pushed a little too far forward, occupied, very nearly, their proper position. The right central and left lateral incisors projected fully a quarter of an inch, lifting and otherwise annoying and disfiguring the upper lip: the left central was thrown behind and partly between the right central and left lateral, while the right lateral occupied a position in a line with it.

Without going into a minute detail of the method adopted for preparing the appliance used, it will be sufficient to refer the reader to Fig. 56. This represents a plaster model of the teeth, alveolar border, palatine arch, and the apparatus for remedying the deformity. The second bicuspids were first extracted, then, by means of ligatures applied to the second molars and first bicuspids, and made fast to a band of gold passing on the outside of the arch, which were renewed every day, these teeth were brought out to their proper position in eleven weeks; this done, there was a space of nearly an eighth of an inch between the cuspids and first bicuspids; this was filled up, by bringing back the cuspids with ligatures. A ligature was next applied to the right lateral, passed through a hole in the gold band in front, and made fast. In ten days this tooth was brought to its proper place. A ligature was now attached to a knob soldered on the gold plate which had been fitted to the inside of the teeth and palatine arch for this purpose, and tied tightly in front of the projecting right central incisor. In about three weeks this was brought to a position alongside the lateral incisor of the same side. The left central was then, in like manner, brought forward, and the left lateral carried backward to its proper place.

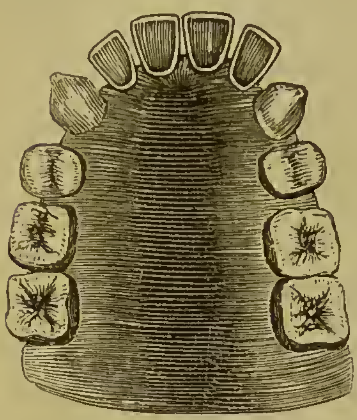
Fig. 56.



After the deformity was corrected, the teeth presented the arrangement represented in Fig. 57, taken from a plaster model made from an impression of the regulated teeth. To correct the

irregularity in this case, required, in all, twenty-one weeks. If all the teeth could have been acted upon at the same time, the operation might have been accomplished in a shorter period. It was found necessary, too, in consequence of the diseased action in the gums, occasioned by the apparatus, to remove it every eight or ten days, and let it remain off each time twenty-four hours. It may be proper also, to observe, that every time the ligatures were removed, it was taken from the mouth, and the teeth thoroughly cleansed.

Fig. 57.



For moving a projecting incisor or cuspid backwards, a gold spiral spring was formerly employed. It was found to be more efficient than a ligature of silk, inasmuch as it kept up a constant traction upon the deviating tooth. But it is objectionable on account of the annoyance it causes the patient. A ligature of gum elastic is far preferable, and this material is now very generally employed in the treatment of every description of irregularity in which agencies of this sort are required. The difficulty of tying india-rubber ligatures is obviated by the use of several sizes of delicate elastic tubing (French manufacture), from which sections may be cut more or less thick, according to the required length and power of the ligature. Each strip becomes thus an endless band which may be readily passed from one tooth to another or to a hook on the plate.

There are other kinds of irregularity of the upper incisors; but we shall only notice one, which, from its peculiar character, is sometimes exceedingly difficult to remedy. It is, when one or more of these teeth are placed so far back in the jaw, that the under teeth come before it or them at each occlusion of the mouth.

Of this kind, Mr. Fox enumerates four varieties: The first is, when one of the central incisors is situated so far back, that the lower teeth shut over it, while the other central remains in its proper place, as represented in Fig. 58, which is copied from his work, as are also those which follow.

The second is, when both of the centrals have come out behind

the circle of the other teeth, and the laterals occupy their own proper position, as represented in Fig. 59.

Fig. 58.

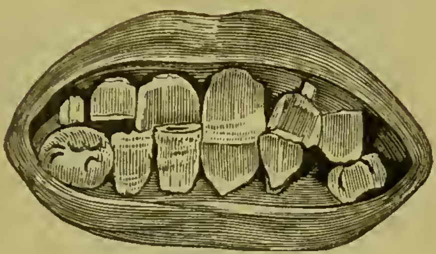
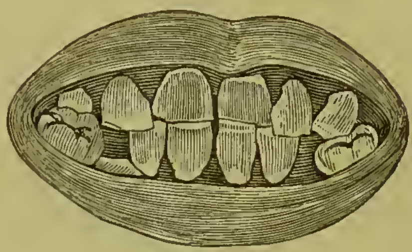


Fig. 59.



The third is, when the lateral incisors are thrown so far back, that the under teeth shut before them, while thé centrals are well arranged, as exhibited in Fig. 60.

Fig. 60.

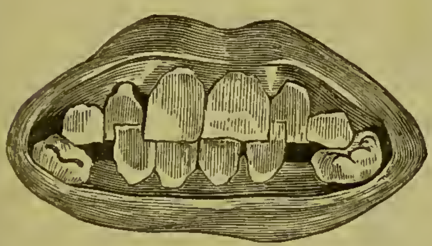
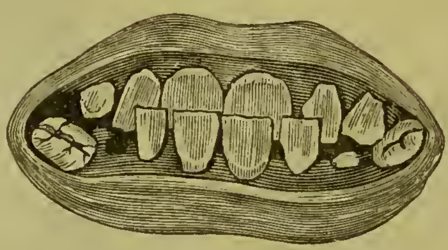


Fig. 61.



The fourth is, when all the incisors are placed so far behind the arch that the lower teeth shut before them, as in Fig. 61.

He might also have added to these a fifth variety; for it sometimes happens that the cuspids of the upper jaw are thrown so far back, as to fall on the inside of the lower teeth. The author has met with several such cases.

Two things are necessary in the treatment of the kind of irregularity just described: first, to prevent the upper and lower teeth from coming entirely together, by placing between them some hard substance, so that the overlapping incisors may not interfere with the necessary outward movement. The second is, the application of some fixture that will exert a constant and steady pressure upon the deviating teeth, until they pass those of the lower jaw.

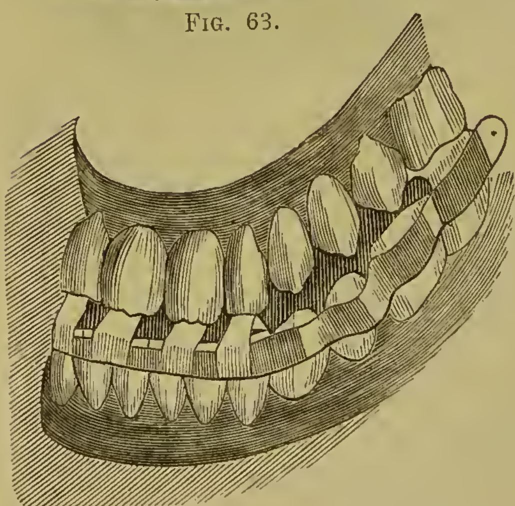
For the accomplishment of this, various plans have been proposed. Duval recommends the application of a grooved or guttered plate, and Catalan has invented an instrument, based, we believe, upon the same principle, but much better adapted to the purpose. We doubted the utility of the inclined plane of

Catalan, until we had employed it, and found it an effectual and speedy method of moving deviating front teeth in the upper jaw, from behind the dental circle to their proper places. It acts with great force, and in the proper manner for the accomplishment of the object. But this very force, and the difficulty of controlling it, make it necessary to be careful in its use, especially upon partially erupted teeth. The fangs of such teeth are in process of formation and of course highly vitalized, and are very susceptible to injury from the shock of repeatedly striking upon the inclined plane.

The accompanying cuts, copied from Catalan, exhibit the manner in which his inclined plane is constructed. The one here represented, is applied to a case where all the upper incisors fall behind the lower front teeth. Its construction should be varied to suit the peculiarity of each case. If but one tooth deviates, only one inclined plane will be required. The apparatus should also be so adapted and secured to the teeth as to occasion as little inconvenience to the patient as possible. The circular bar or plate of gold, running round in front of the teeth, should reach from the first molar on one side to the first molar on the other, and the plate, extending up from it should cover the grinding surfaces of these teeth and be long enough to cover their lingual faces also, as the whole fixture will thereby be rendered firmer and more secure.

Fig. 62.

Fig. 63.



In the application of this principle for the correction of irregularity, the author has been in the habit of constructing the apparatus somewhat differently. With a brass model and zinc countermodel, he has a plate of gold struck up over all the teeth, when practicable, as far back as the first or second molar, completely

encasing them and the alveolar ridge. An encasement of this sort (Fig. 64), possesses greater stability than can be obtained for an appliance like the one represented in Figs. 62 and 63.

FIG. 64.

FIG. 65.

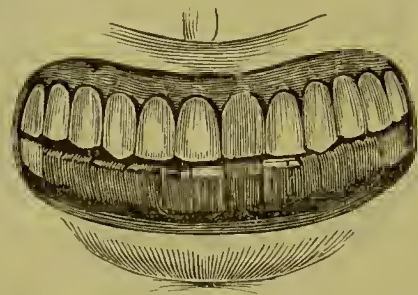
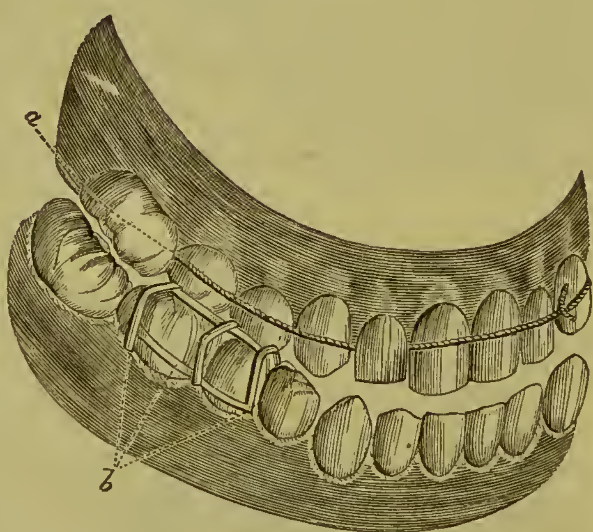


FIG. 66.



In Fig. 64, is seen a representation of an inclined plane for bringing forward a central incisor which had come out about a quarter of an inch behind the circle of the other teeth. The manner of the action of this instrument upon the deviating tooth is shown in Fig. 65.

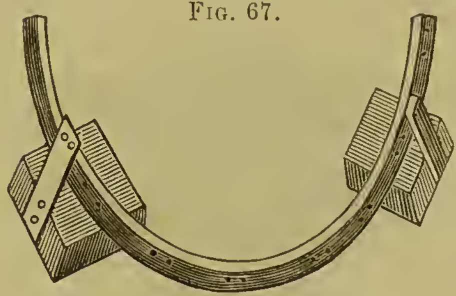
The plan proposed by Delabarre, as shown in Fig. 66, taken from his treatise on second dentition, is to pass silk ligatures (*a*) around the teeth, in such a way that a properly directed and steady pressure will be exerted on such of the teeth as are situated behind the arch. To keep the jaws from coming in contact, he recommends the application of a metallic grate (*b*) fitted to two of the inferior molars.

This plan possesses the merit of simplicity, and occasions little or no inconvenience to the patient. It will, however, sometimes be found not only inefficient, but also injurious in its action upon the teeth adjacent to those to be brought forward. The force on the irregular teeth, and those against which the ligatures act, being equal, and in opposite directions, the latter will be drawn back, while the former are brought forward; thus the means used for the correction of one evil, will sometimes occa-

sion another. The author has tried it, however, in some cases, with the most satisfactory results.

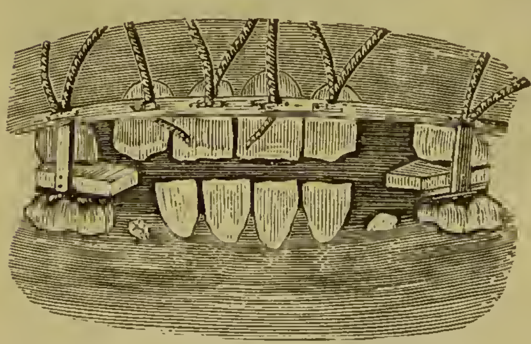
Mr. Fox recommends a gold bar about the sixteenth part of an inch in width, and of proportionate thickness, bent to suit the curvature of the mouth, and fastened with ligatures to the temporary molars of each side. It is pierced opposite each irregular tooth with two holes. The teeth of the upper and lower jaw are prevented from coming entirely together by means of thin blocks of ivory, attached to each end of the bar by small pieces of gold, and resting upon the grinding surfaces of the temporary molars. Fig. 67.

Fig. 67.



After the instrument has been thus fastened to the teeth, silk ligatures are passed round such as are within the arch, and through the holes opposite them, and then tied in a firm knot, on the outside of the bar. Fig. 68.

Fig. 68.



The ligatures must be renewed every three or four days, until the teeth shall have come forward far enough to strike in front of those that formerly shut before them, and until they shall have acquired a sufficient degree of firmness to prevent them from returning to their former position. As soon as the teeth shut perpendicularly upon each other, the blocks may be removed, and the bar alone retained.

Since 1830, many practitioners, both in England and the United States, have substituted caps of gold for the blocks of ivory recommended by Mr. Fox, and instead of simply bending the bar, they now swage it between metallic casts so that all its parts, except those immediately opposite the irregular teeth, may be perfectly adapted to the dental circle. The apparatus, with these modifications, is more comfortable, and less liable to move upon the teeth.

Mr. Fox directs, that the blocks of ivory be placed upon the temporary molars; but the caps of gold now substituted are entirely disconnected from the bar, and are often used after the moulting of these teeth; they are then placed upon the first permanent molars. As the caps prevent the teeth from coming together, mastication, during the time they are worn, is, necessarily, performed on them. They should, therefore, be placed upon the largest and strongest teeth; and for this reason they should be applied to the molars.

The curved bar should be washed, and the teeth cleansed every time the ligatures are renewed. If this be neglected, the particles of food that collect between it and the teeth, will soon become putrid and offensive, constituting a source of disease both to the gums and teeth. Before the bar is applied, it should be ascertained whether there is sufficient space for the deviating teeth, and if there is not, room should be made in the manner before described.

Some diversity of opinion exists as to the most suitable age for the correction of this description of irregularity. Mr. Fox, it would seem, preferred the period immediately previous to the shedding of the temporary molars—probably the tenth or eleventh year after birth. Others think, that the forepart of the dental arch continues to expand until the second denture is completed, and that the bicuspids afford a better support for the ends of the bar than any other teeth, and are content to wait until the fifteenth or even sixteenth year. But, though the arch does sometimes expand a little, yet even when the expansion occurs, it is generally so inconsiderable, that little advantage can be derived from it. Moreover, the arch, instead of expanding, is much more liable to contract whenever a vacancy occurs in the dental circle, either by the extraction, or from the improper growth of one or more of the teeth; hence, the difficulty is apt to be increased by delay. The evil, it is true, may be remedied at the fifteenth, seventeenth, or even eighteenth year; but it is rarely advisable to defer it to so late a period.

The most that is required in the treatment of irregularity of the lower incisors, is to remove a tooth, and to apply frequent pressure to the deviating organs. The lower incisors are less conspicuous than those of the upper jaw, and the loss of one, if the others are well arranged, is scarcely perceptible.

The use of vulcanite or hardened india rubber promises to be of great value in the correction of irregularities. The peculiar manipulations it requires will be found in another portion of this work; it is only necessary, therefore, in concluding this chapter, to briefly mention the properties which fit it for this important branch of dental practice.

It admits of absolutely perfect adaptation to the teeth. If only a part of the crowns of the teeth require fitting, a wax impression will be sufficiently accurate. But if the gum and undercut surfaces of the teeth are to be fitted, a plaster impression is necessary. Professor Austen's method of taking plaster impressions in gutta-percha cups, will enable a skillful operator to take an accurate impression of any mouth, however irregularly the teeth may be arranged.

A closely fitting vulcanite plate can be worn with comfort; hence the patient is not tempted to remove it. It has no motion, hence does not wear the teeth or irritate the gums. Its firmness of adaptation makes it an excellent "fixed point," from which to make pressure or traction in any required direction upon the irregular teeth: the counter pressure, being distributed over all the regular teeth, is not felt. When it is necessary to cap the molars, a layer of varying thickness should be carried over them all, to prevent the soreness caused by mastication upon any one tooth.

Any variety of appliance may be used in connection with the plate, that the judgment of the operator suggests, as best adapted to bring about the required change. The plastic nature of the crude material permits enlargement or extension in any direction, without the necessity of soldering, as in metallic plates, and with an exactness which cannot be had in carving ivory blocks.

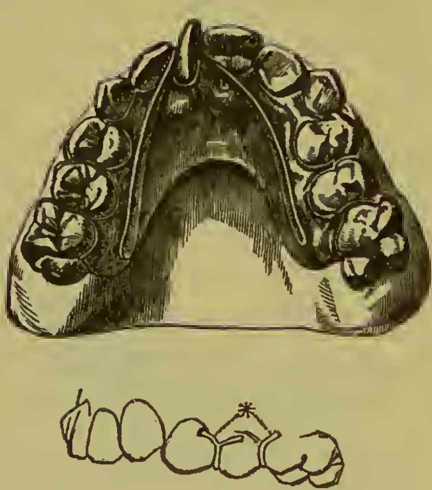
Thus, prominences may be left behind teeth which are to be moved outwards; in which may be made dovetails for the insertion of compressed wood; slits or holes for india rubber, which makes more rapid pressure than the wood; or holes for the insertion of small screws. These screws may bear directly against the tooth, and be turned slightly each day or two. Or the portion of the plate next the tooth or teeth to be moved may be separated with a delicate saw from the plate; the ends of the screw

or screws playing into this, move the tooth or teeth by a broad bearing, which will, in certain cases, be better than the point of the screw.

Or a small piece of vulcanized rubber may be taken ; one end fitting against a molar or bicuspid, and into the other end a screw thread cut to receive a delicate screw ; on the head of this screw a second piece of rubber may be fitted against the tooth to be moved so as to allow the screw to be turned without changing its position on the tooth. This combination forms a miniature jack-screw, similar to those recommended some years since by Dr. Dwinelle, and will often be found useful. It may be used in combination with the rubber plate by attaching one end to the plate instead of resting it against a tooth.

If it is desired to move a tooth by the elasticity of a spring, this can be made of vulcanite ; one end of it fitted tightly into a groove cut in the plate, so that the free end shall bear with the requisite force against the tooth. The elastic slip or spring can readily be bent, by means of a warm burnisher, so as to press with greater or less force, as the case may demand. Fig. 69, taken from Mr. Tomes' work, will illustrate one variety of the application of springs; in this case pressing outward and laterally the left central and right lateral incisors. This mode of making pressure will be found very useful. It acts steadily, is under control, and does not need renewal so often as the wedges of wood or rubber.

Fig. 69.



Where ligatures are required, the vulcanite plate affords an easy means of attaching them in any desired position ; passing them through holes and tying ; looping them over projecting knobs of vulcanite, or over small metal hooks set in the plate ; or stretching them through slits sawn in the plate.

If a band is to be carried for any purpose in front of the arch, it may be connected with the plate on the inside of the arch, through any spaces occurring between the bicuspids or molars ;

if there are no such spaces, or if they are to be closed up in the process of regulation, the cap which is often required to pass over the molars will connect the two. But the outside band is not often necessary. The inside plate is less awkward to the patient, it is out of sight; and almost, if not quite, every required movement can be obtained from it, even to the exclusion of the inclined plane of Catalan.

The case described on page 152, Fig. 55, could have been advantageously treated by the use of a vulcanite plate; the various stages progressing nearly at the same time. The impression in this case to be taken in plaster; the plate capping the second molars; first molars and first bicuspids carried outward by wooden or elastic wedges, or by a double spring of vulcanite, fastened to the plate opposite each space of the extracted second bicuspids; the left central and right lateral carried out by wedges or screws; the right central and left lateral brought in by ligatures looped over hooks in the plate. At the completion of the work a new impression to be taken, and the plate worn until the teeth become firmly set, passing a ligature around the two outstanding teeth, to prevent their tendency to return to their old positions; the plate itself would keep the others in place.

A text book can only give general principles and illustrate them by a few examples; for the varieties of irregularity are almost endless. Their successful treatment demands a correct knowledge of physiological and pathological action to know when and where to act; a skillful hand and an inventive wit to know just what to do and how to do it.

In conclusion, to sum up briefly—do not interfere where by simple extraction the case will correct itself: when teeth must be moved, do it decidedly, to avoid tedious delay; but take care not to be so rapid as to excite inflammation: do not move teeth with deformed or defective fangs; do not sacrifice sound and regular bicuspids, to bring into the arch teeth which will require to be moved through a great space; for this movement materially impairs their durability; lastly, do not attempt to bring teeth to a position where you cannot keep them until firm ossific deposit makes them permanent in their new positions.

CHAPTER THIRTEENTH.

DEFORMITY FROM EXCESSIVE DEVELOPMENT OF THE TEETH AND ALVEOLAR RIDGE OF LOWER JAW.

When the teeth of the lower jaw form a larger arch than those of the upper, the incisors and cuspids of the former shut in front of those of the latter, causing the chin to project, and otherwise impairing the symmetry of the face. Figs. 70 and 71 present a front and a side view of this deformity. It may result from a want of correspondence in the development of the teeth and alveoli of the two maxillæ: the upper jaw being defective in size, whilst the lower jaw is natural; or the former being natural, the latter may be in excess. It may also arise from a simple eversion of the lower teeth or inversion of the upper.

Fig. 70.

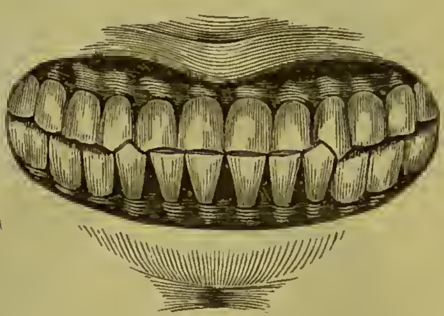
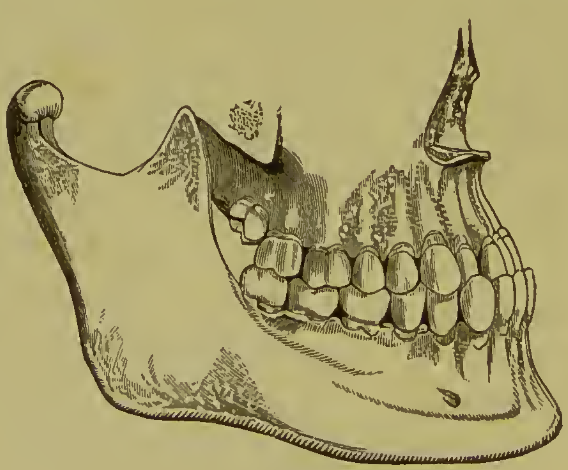


Fig. 71.



TREATMENT.

The remedial indications of the deformity in question consist in diminishing the size of the dental arch, which is always a tedious and difficult operation, requiring great patience and perseverance on the part of the patient, and much mechanical ingenuity and skill on the part of the dentist. The appliances to be employed have, of necessity, to be more or less complicated, requiring the most

perfect accuracy of adaptation and neatness of execution; they must also be worn for a long time, and, as a natural consequence, are a source of considerable annoyance. The first thing to be done, is to extract the first inferior bicuspids. Sufficient room will thus be obtained for the contraction, which it will be necessary to effect in the dental arch, for the accomplishment of the object. An accurate impression of the teeth and alveolar ridge should be taken with wax, softened in warm water, and from this impression, a plaster model is procured, and afterwards, a metallic model and counter-model, in the manner to be described in a subsequent chapter.

This done, a gold plate of the ordinary thickness should be swaged to fit the first and second molars, (if the second has made its appearance, and if not, the second bicuspid and first molar on each side,) so as completely to incase these teeth. If these caps are not thick enough to prevent the front teeth from coming together, a piece of gold plate may be soldered on that part of each which covers the grinding surfaces of the teeth. Having proceeded thus far, a small gold knob is soldered to the inner and outer front corners of both caps, and to each of these a ligature of silk or gum elastic is attached. These ligatures are to be brought forward and tied tightly around the cuspids. When thus adjusted, the lower arch will present the appearance exhibited in Fig. 72. By this means the cuspids may, in fifteen or twenty days, be taken back to the bicuspids. If in their progress they are not carried towards the inner part of the alveolar ridge, the outer ligatures may be left off after a few days, and the inner ones alone employed to complete the remainder of the operation.

Fig. 72.

After the positions of the cuspids have been thus changed, a circular bar of gold should be made, extending from one cap to the other, so as to pass about a quarter of an inch behind the incisors, and be soldered to the inner side of each cap. A hole is to be made through this band behind each of the incisors,

through which a ligature of silk may be passed and brought forward and tied tightly in front of each tooth. These ligatures should be renewed every day until the teeth are carried far enough back to strike on the inside of the corresponding teeth in the upper jaw.

Fig. 73 represents the appearance which the lower jaw presents with the last-named apparatus upon it, and will better convey an idea of its construction, the manner of its application, and its mode of action, than any description which can be given.

Fig. 73.

An appliance of this sort may be made to act with great efficiency in remedying the deformity in question; but, in its application, it is necessary that the caps be fitted with the greatest accuracy to the teeth, and they should be removed every day and thoroughly cleansed, as well as the teeth they cover. If this precaution is neglected, the secretions of the mouth, which collect between the gold caps and teeth, will soon become acrid and corrode the latter.

The remarks made in the previous chapter upon the use of the vulcanite are applicable here. Such a plate, for this class of cases, is readily made, and inflicts no injury upon teeth or gums. Elastic, instead of silk, ligatures might be used, and the retraction of the incisors carried on simultaneously with that of the cuspids.

CHAPTER FOURTEENTH.

PROTRUSION OF THE LOWER JAW.

THIS deformity, although produced by a different cause from the one last described, is similar to it, and gives to the lower part of the face an unnatural and sometimes disagreeable appearance. It also interferes with mastication, and often with prehension and distinct utterance. It wholly changes the relationship which the teeth should sustain to each other when the mouth is closed. The cusps or protuberances of the bicuspids and molars of one jaw, instead of fitting into the depressions of the corresponding teeth of the other, often strike their most prominent points; at other times the outer protuberances of the lower molars and bicuspids, instead of fitting into the depressions of the same class of teeth in the upper jaw, shut on the outside of these teeth. The trituration of aliments is consequently rendered more or less imperfect.

This protrusion of the lower jaw is supposed by some to be the result of a "natural partial luxation." In fact, its causes are by no means clearly understood. It is often hereditary, and would seem to be caused by that mysterious agency which impresses peculiarities of growth and shape, not only upon the lower maxilla, but upon every bone in the body. This agency is so constant and over-ruling, that we must be prepared to find the jaw returning to its position after the discontinuance of treatment; unless, by the interlocking of the cusps of the upper teeth and the overlapping of the upper incisors, we can restrain the tendency. It is of more frequent occurrence than the one which results from excessive development of the teeth and alveolar ridge, and requires, as before stated, an entirely different plan of treatment. It rarely occurs previously to second dentition.

TREATMENT.

The plan of treatment usually adopted, consists in fastening on each side a small block of ivory or a cap of vulcanite on one

of the lower molars, thick enough to keep the front teeth about a quarter of an inch apart when the jaws are closed. Fox's bandage must now be applied. This is buckled as tightly as the patient can bear with convenience, pressing the chin upward and backward. A piece of tough wood, slightly hollowed so as to fit the arch of the lower teeth, made narrow at the upper end, is introduced between the teeth several times a day, the concave portion resting upon the outside of the lower, and against the inside of the upper, employing at each time as much pressure as can be safely applied. By continuing this operation from day to day, for several weeks, the natural relationship of the jaws will, in most cases, be restored.*

The description of bandage here alluded to, and the manner of its application, is represented in Fig. 74. When the protrusion of the lower jaw is accompanied by irregularity, means should, at the same time, be employed for remedying it. The earlier the treatment is instituted, the more easily will the deformity be overcome. It may, however, be successfully remedied at any time previously to the twentieth year of age, and sometimes at a much later period; but after this time the operation becomes more difficult.

Fig. 74.

In cases where the lower front teeth close over the upper, and thus cause a deformity of the face, it is important to discriminate correctly between those which result from malformation, and a protrusion of the jaw occasioned by partial luxation, as the remedial indications in the two are entirely different. Those which would prove successful in the one, would prove unsuccessful in the other. But, fortunately, deformity arising from the last mentioned cause is, comparatively, of rare occurrence; hence the dentist is seldom called upon to exercise his ingenuity and skill in its treatment.

* An interesting article by Dr. J. S. Gunnell, on the treatment of deformities of this kind, is contained in one of the early volumes of the American Journal of Dental Science.

CHAPTER FIFTEENTH.

PECULIARITIES IN THE FORMATION AND GROWTH OF THE TEETH.

In the development and growth of the various parts of the body, curious and interesting anomalies are sometimes observed, but in no portion of it are they more frequent in their occurrence or diversified in their character than in the teeth. But aberrations in the formation and growth of these organs, are, for the most part, confined to the teeth of second dentition.

Mr. Fox gives a drawing of a tooth very nearly resembling the letter S. The malformation was caused by an obstructing temporary tooth. The author has also met with several examples of teeth similarly deformed, and from like causes.

The molars of the upper jaw sometimes have four and even five roots, and those of the lower, three, and occasionally four. The crowns of the teeth, also, frequently present deviations from the natural shape equally striking and remarkable.

The next peculiarity to be noticed is that of size, and in this respect the teeth are very variable. Even in the same mouth, the want of relative proportion between the different classes of teeth is sometimes quite conspicuous. But examples of this kind are not very frequent, for where there is an increase or diminution in the size of the teeth of one class, there is generally a corresponding change in that of the other.

Aberrations of this character are probably dependent upon some diathesis of the general system, whereby the teeth, during the earlier stages of their formation, are supplied with an excessive or diminished quantity of nutriment.

Some very remarkable deviations have been known to take place, in the growth of the teeth. The most singular case on record, is that narrated by Albinus: "Two teeth," says he, "between the nose and the orbits of the eye, one on the right side and the other on the left, were enclosed in the roots of

those processes that extend from the maxillary bones to the eminence of the nose. They were large, remarkably thick, and so very like the canines, that they seemed to be these teeth, which had not before appeared; but the canines themselves were also present, more than usually small and short, and placed in their proper sockets. The former, therefore, appear to have been new canines, which had not penetrated their sockets, because they were situated where these same teeth are usually observed to be in children. But what is still more remarkable, their points were directed towards the eyes, as if they were the new eye teeth inverted. And they were also so formed, that they were, contrary to what usually happens, convex on the posterior, and concave on the anterior."* A case of a somewhat similar character is mentioned by Mr. John Hunter.

The following case is in the words of Mr. G. Wait: "While I was prosecuting my anatomical studies, I was struck with the appearance of a cuspid of the upper jaw; it was short, and appeared as if the body of the tooth was in the jaw, and that it was the tip of the root that presented itself. Upon further examination, I found this verified; and after the cranium and lower jaw were properly macerated and cleansed, I found one of the lower bicuspids in the same position."

The author can readily imagine that a cuspid of the upper jaw might, while in a rudimentary state, by some false or unnatural attachment of the dental sac, be so altered in its position, as to pass up, in its growth, between the nose and orbit. But that the crown, after having been thus turned round in the socket, should remain stationary, while the fang passed down and appeared outside of the gum, is a most extraordinary and remarkable anomalism. In the former instance, the tooth might still continue to derive the nutriment necessary for its vitality from the dental vessels; but in the latter case, it could not be

* "Dentes duo inter nasum et orbes oculorum, dexter sinisterque, inclusi in radicibus processuum quibus ossa maxillaria ad eminentem nasum pertinent. Longi sunt, crassitudinis insignis. Similes maxime caninis, ut videri possint illi ipsi esse, non nati. At aderant præterea canini præter consuetudinem parvi, et breves, suis infixi alveolis. Itaque videantur esse canini novi qui non eruperint, utpote ibi loci collocati, ubi sunt novi illi in infantibus. Sed quod miremur, sursum devecti, tanquam si sint canini novi inversi. Et ii quoque formati sunt ut, contra quam alii, a posteriore parte gibbi, ab anteriore sinuati sint," &c.—*Academ. Anastat.* liber 1, p. 54.

so nourished without difficulty, because the apex of the root, the place where the vessels and nerves enter, was entirely outside of the gum.

The following is one of the several cases of deviation in the growth of the teeth, that have come under the author's observation: In 1840, he was requested to extract a tooth for a lady of Baltimore, under the following circumstances. She had, for a time, experienced a great deal of pain in her upper jaw, and supposed it to originate from the second molar of the right side, but which was perfectly sound. Meanwhile her general health became impaired, and her attending physician, thinking that the local irritation might have contributed to her debility, advised the extraction of the tooth. On removing it, the cause of the pain at once became apparent. The dens sapientiæ, which had not hitherto appeared, was discovered with its fangs extending back to the utmost verge of the angle of the jaw; while its grinding surface had been in contact with the posterior surface of the crown and neck of the tooth just extracted. On the removal of the wisdom tooth, the pain ceased.

About the middle of December, 1849, a youth aged sixteen, applied to the author to extract a right superior bicuspid, which, he said, was ulcerated at the root. On examining his mouth, he discovered only one bicuspid, but above and between the root of this and that of the first molar, he observed a small fistulous opening. On introducing a small probe, it immediately came in contact with the crown of a tooth looking towards the malar process of the superior maxillary, which, on extraction, proved to be the second bicuspid.

The author has in his possession several molar and bicuspid teeth, which have small nodes upon their necks, covered with enamel; and there is a jaw in the Museum of the Baltimore Dental College, which has five teeth presenting this anomaly.

The author has two teeth in his possession, of most singular shape, presented to him by his brother, the late Dr. John Harris. They were extracted in July, 1822, from the right side of the upper jaw of a young gentleman, nineteen years of age, by the name of Crawford. They occupied the place of the first and second bicuspids, and their crowns are almost wholly imbedded in lamellated dentine, that should have constituted their roots,

but which are entirely wanting. Judging from their appearance, one would be inclined to suppose, that their sacs failing to contract, they remained stationary in their sockets, and as the base of the pulps elongated, they came in contact with the bottom of the alveoli and were caused to bulge out and to be reflected upon their crowns; to the enamel of which, nearly to their grinding surfaces, they are perfectly united. For some time previously to the extraction of these teeth, they had been productive of considerable irritation and pain in the gums and jaw, and it was for the relief of the suffering which their presence induced, that they were removed.

Since the publication of the second edition of this work, the author has seen a still more remarkable deviation in the growth of a tooth. It is in the upper jaw of an adult skull in the Museum of the Baltimore Dental College. The natural teeth are all well formed, and regularly arranged in the alveolar border, but between the extremities of the roots of the superior central incisors, in the substance of the jaw, there is a supernumerary tooth, the crown of which looks upward toward the crest of the nasal plates of the two bones. The whole tooth is about one inch in length, and the apex of the crown is nearly on a level with the floor of the nasal cavities. There is also in the museum of this institution a central incisor of the upper jaw, with the root bent upon, and in contact with, the labial surface of the crown.*

* This tooth was presented to the author by Dr. Williams, dentist, of Alexandria, Va.

CHAPTER SIXTEENTH.

OSSEOUS UNION OF THE TEETH.

Inclosed as each tooth is, in a distinct sac, and separated on either side by a bony partition, from the adjoining teeth, until after the completion of the formation of the enamel, it is difficult to conceive how osseous union could take place between two of these organs, and, we confess, that until we actually witnessed an example of it, which we did for the first time in 1836, we were inclined to doubt the possibility of such an occurrence.

During a visit to the city of Richmond, Va., in April, of the above mentioned year, we had an opportunity of seeing two cases. One consisted in the union of the crowns of the central incisors of the upper jaw, the palatine surface of which presented the appearance of one broad tooth, while anteriorly, they had the semblance of two teeth; the other case consisted in the union of the right central and lateral incisors of the lower jaw.

A professional friend in Virginia informed the author, in a conversation some years since, that he had met with a case of osseous union between a second bicuspid and first molar of the lower jaw, which was so palpable, that there could have been no doubt of its existence.

Mr. Fox has given the drawings of four cases, the originals of which, as Mr. Bell tells us, are still to be seen in the museum of Guy's Hospital. Mr. B. also informs us, that he has seen four other examples.

Dr. Koecker is skeptical with regard to the existence of osseous union of the teeth, and attributes to those who assert that they have met with cases of it, "a weak credulity, a love of the marvelous, or a desire to impose upon the world."

Cases of this sort, it is true, are of rare occurrence, and a connection of the fangs of two teeth, by an intervening portion of the alveolus, is very easily mistaken for osseous union of the roots themselves. A few years since, in extracting a second

molar of the upper jaw, the author brought the dens sapientiæ along with it. At first he thought there was osseous union of the roots, but upon close examination, found a very thin portion of the alveolar wall between, to which their roots were firmly attached. Such a case as this would, in many instances, be set down as an example of osseous union.

It is easy to account for a *lusus naturæ* of this kind, by supposing a previous union of the pulps of the two teeth. But from the order in which the eruption of the teeth is effected, some classes appearing long before others, it would, on this supposition, seem that it could only occur between the central incisors. It is not, however, thus limited: the central and lateral incisors, the bicuspids, and the molars, are sometimes united.

An osseous union of the teeth is, fortunately, of rare occurrence; if it were otherwise, it would be productive of many accidents in the extraction of teeth. Apart from this consideration, it can be of but little importance, either to the practitioner or to the physiologist.

Since the publication of the first edition of this work, several cases of osseous union of the teeth have fallen under the observation of the author, and he now has several specimens in his anatomical collection. He has five examples of osseous union of the temporary teeth.*

The author has more recently met with several other examples of osseous union of temporary teeth.

* For the specimens above alluded to, the author is indebted to Dr. Cassell, Mr. Townsend and Dr. Dwinelle.

CHAPTER SEVENTEENTH.

SUPERNUMERARY TEETH.

The development of supernumerary teeth is usually confined to the anterior part of the mouth, and more frequently to the upper than to the lower jaw. They sometimes, however, appear as far back as the dentes sapientiæ, and Hudson says, he has seen them behind these teeth. We have now in our anatomical collection, two supernumerary teeth that were extracted, one from behind, and the other at the side, of one of the upper wisdom teeth.*

The crowns of supernumerary teeth which appear in the anterior part of the mouth, are usually of a conical shape, and for the most part, situated between the central incisors; they usually have short, knotty roots; sometimes, however, they bear so strong a resemblance to the other teeth, that it is difficult to distinguish the one from the other. We once saw two lateral incisors in the lower jaw, both of which were so well arranged, and perfectly formed, that it was impossible to determine which of the two ought to be considered as the supernumerary. Mr. Bell mentions a case, in which there were five lower incisors, all of which were well formed and regularly arranged. The author has met with several examples in which supernumerary teeth in the lower jaw so closely resembled the natural incisors, that no difference could be discerned between them. He has also seen examples of three lateral incisors in the upper jaw, where it was impossible to determine which was the supernumerary.

Supernumerary cuspids rarely if ever occur, but supernumerary bicuspids are occasionally met with. Delabarre says, he has seen them; and we have met with three examples of the sort; in each of these instances the teeth were very small, not being more than one-fourth as large as the natural bicuspids, with oval crowns, and placed partly on the outside of the circle,

* These teeth were removed by Dr. Chowning, dentist, of Fredericksburg, Va.

and partly between the bicuspids. We extracted one of them, and have it still in our possession. Its root is short, round, and nearly as thick at its extremity as it is at the neck of the tooth.

The supernumerary teeth that appear further back than the bicuspids, though much smaller, bear a strong resemblance to the dentes sapientiæ.

Supernumerary teeth, although generally imperfect in their formation, are less liable than other teeth to decay. This may be attributable to the fact, that they are harder, and, consequently, not so susceptible to the action of the causes that produce the disease.

Although the occurrence of supernumerary teeth rarely disturbs the arrangement of the others, their presence is sometimes productive of the worst kind of irregularity; and even when they do not have this effect, they impair the beauty of the mouth, and, for this reason, should be extracted as soon as their crowns have completely emerged from the gums.

To the practitioner of dental surgery, the occurrence of supernumerary teeth is interesting, only in so far as it affects the beauty of the mouth and the relationship which the teeth of the upper jaw sustain to those of the lower; but to the physiologist, it involves the question, what determines their development? In propounding this interrogatory, however, it is not our intention to enter upon its discussion in this place, as it forms no part of the design of the present treatise.

CHAPTER EIGHTEENTH.

THIRD DENTITION.

That nature sometimes makes an effort to produce a third set of teeth, is a fact which, however much it may be disputed, is now so well established, that no room is left for cavil or doubt.

The following interesting particulars are taken from "Good's Study of Medicine:"

"We sometimes, though rarely, meet with playful attempts on the part of nature, to reproduce teeth at a very late period of life, and after the permanent teeth have been lost by accident, or by natural decay.

"This most commonly takes place between the sixty-third and eighty-first year, or the interval which fills up the two grand climacteric years of the Greek physiologist; at which period the constitution appears occasionally to make an effort to repair other defects than lost teeth. * * *

"For the most part, the teeth, in this case, shoot forth irregularly, few in number, and without proper fangs, and, even where fangs are produced, without a renewal of sockets. Hence, they are often loose, and frequently more injurious than useful, by interfering with the uniform line of indurated and callous gums, which, for many years perhaps, had been employed as a substitute for the teeth. A case of this kind is related by Dr. Bisset, of Knayton, in which the patient, a female in her ninety-eighth year, cut twelve molar teeth, mostly in the lower jaw, four of which were thrown out soon afterwards, while the rest, at the time of examination, were found more or less loose.

"In one instance, though not in more than one, Mr. Hunter witnessed the reproduction of a complete set in both jaws apparently with a renewal of their sockets. 'From which circumstance,' says he, 'and another that sometimes happens to women at this age, it would appear that there is some effort in nature to renew the body at that time.'

"The author of this work once attended a lady in the country, who cut several straggling teeth at the age of seventy-four; and, at the same time, recovered such an acuteness of vision, as to throw away her spectacles, which she had made use of for more than twenty years, and to be able to read with ease the smallest print of the newspapers. In another case, that occurred to him, a lady of seventy-six, mother to the late Henry Hughes Eryn, printer of the journals of the House of Commons, cut two molars, and at the same time completely recovered her hearing, after having for some years been so deaf as to be obliged to feel the clapper of a small hand-bell, which was always kept by her, in order to determine whether it rung or not.

"The German Ephemerides contain numerous examples of the same kind; in some of which, teeth were produced at the advanced age of ninety, a hundred, and even a hundred and twenty years. One of the most singular instances on record is that given by Dr. Slade, which occurred to his father; who, at the age of seventy-five, reproduced an incisor, lost twenty-five years before, so that, at eighty, he had hereby a perfect row of teeth in both jaws. At eighty-two, they all dropped out successively; two years afterwards, they were all successively renewed, so that at eighty-five, he had once more an entire set. His hair, at the same time, changed from a white to a dark hue; and his constitution seemed, in some degree, more healthy and vigorous. He died suddenly, at the age of ninety or a hundred.

"Sometimes these teeth are produced with wonderful rapidity; but in such cases, with very great pain, from the callosity of the gums, through which they have to force themselves. The Edinburgh Medical Commentaries supply us with an instance of this kind. The individual was in his sixty-first year, and altogether toothless. At this time, his gums and jaw-bones became painful, and the pain was at length excruciating. But, within the space of twenty-one days from its commencement, both jaws were furnished with a new set of teeth, complete in number."

A late physician of Baltimore informed the author in 1838, that an example of third dentition had come under his own observation. The subject, a female, at the age of sixty, he assured him, erupted an entire set in each jaw.

The following extract of a letter from a professional friend,* describes another very interesting case.

"I have just seen a case of third dentition. The subject of this 'playful freak of nature,' as Dr. Good styles it, is a gentleman residing in the neighborhood of Coleman's Mill, Caroline County, Virginia. He is now in his seventy-eighth year, and, as he playfully remarked, 'is just cutting his teeth.' There are eleven out, five in the upper, and six in the lower jaw. Those in the upper jaw are two central incisors, one lateral and two bicuspids, on the right side. Those in the lower are the four incisors, one cuspid and one molar. Their appearance is that of bone, extremely rough, without any coating or enamel, and of a dingy brown color."

Two cases somewhat like the foregoing, have come under the author's observation. The subject of the first was a shoemaker, Mr. M., of Baltimore, who erupted a lateral incisor and cuspid at the age of thirty. Two years before this time, he had been badly salivated, and, in consequence, lost four upper incisors and one cuspid. The alveoli of these teeth exfoliated, and, at the time he first saw him, were entirely detached from the jaw and barely retained in the mouth by their adhesion to the gums. On removing them, he found two white bony protuberances, which, on examination, proved to be the crowns of an incisor and cuspid. They were perfectly formed, and though much shorter than the other teeth, yet, up to the present time, 1845, have remained quite firm in the jaw.

The subject of the other case was a lady, residing near Fredericksburg, Virginia, who erupted four right central incisors of the upper jaw successively. One of her temporary teeth, in the first instance, had been permitted to remain too long in the mouth, and a permanent central incisor, in consequence, came out in front of the dental arch. To remedy this deformity, the deciduous incisor was, after some delay, removed; and, about two years after, the permanent tooth, not having fallen back into its proper place, was also extracted. Another two years having elapsed, another tooth came out in the same place and in the same manner, and, for similar reasons, was also removed. To the astonishment of the lady and her friends, a fourth incisor

* Dr. J. D. McCabe.

made its appearance in the same place, two years and a half after the extraction of the first permanent tooth. When it had been out about eighteen months, the author was called in by the lady, who wished him, if possible, to adjust it. Finding that it could not be brought within the dental circle, he advised her to have it extracted, and an artificial tooth placed in the proper place in the arch.

In the second number of the eighth volume of the American Journal of Dental Science, the history of a case of four successive dentitions of the upper central incisors is given.*

It is said that the efforts made by nature, for the production of a third complete set of teeth, are so great, that they exhaust the remaining energies of the system; and, as a consequence, that occurrences of this kind are generally soon followed by death.

The author is not aware that any attempt has ever been made to explain the manner of the origin and formation of the teeth of third dentition. The rudiments of the teeth of first and second dentition originate from mucous membrane, while those of third dentition would seem to be the product of the periosteal tissue or bone.

In obedience to what law of developmental anatomy are the teeth of third dentition formed? Certainly not to any one primitively impressed upon the animal economy, as they have never been known to appear while the teeth of second dentition remain in the jaws. If the establishment of the law which governs the development of a part, depends upon a certain condition of other contiguous parts, it is possible that the following may be a correct explanation of the phenomenon of third dentition. Certain parts, in certain states or conditions, and in particular locations, perform functions peculiar to themselves. In other words, the condition and location of a part determines the function or functions it performs. For example, when the mucous membrane along the course of the alveolar border begins to assume a duplicated or grooved condition, which it does at about the sixth week of intra-uterine existence, dental papillæ shoot up from it; and when, by a similar duplication of this same tissue, behind the sacs of the temporary teeth, forming what Mr. Goodsir styles

* Dr. W. H. Dwinelle.

"cavities of reserve," the papillæ of the permanent teeth, one from the bottom or distal extremity of each duplication, begins to be developed. Hence, it would seem that this particular state or condition of this tissue, and in these particular locations, is necessary to determine the development of teeth germs. This arrangement or condition of mucous membrane, in these particular locations, which always results from the development of the fœtus, may be sometimes produced by accidental causes, after all the organs of the body have attained their full size, or at any time during life; and when it does occur, it is not unreasonable to suppose that a new tooth papilla should be formed. Proceeding still farther, the development of a dental papilla is the signal for the production of a dental follicle, which ultimately becomes a sac, and then an organ to supply the tooth, now considerably advanced in the process of formation, with a covering of enamel. But as the maxillary bone has previously attained its full size, it rarely, if ever, happens that alveoli are formed for these accidental productions, and, consequently, they seldom have roots, or if they do, they are very short and blunt. They are usually connected with the periosteum of the alveolar border; and this union is sometimes so close and intimate, that very considerable force is necessary for their removal, or at least, so far as our own observations go upon the subject, and we have had occasion to extract several in the course of our practice. As a general rule, however, they become loose in the course of a few years and drop out.

But it may be asked, how are such accidental duplications of the mucous membrane formed? This is a question, we admit, which it may not be easy to answer satisfactorily, but we do not think it at all improbable, that they sometimes occur during the curative process that follows the removal of one or more teeth. The granulated walls of the gums surrounding an alveolus from which a tooth has been extracted, may become covered with this tissue before the socket is filled with a deposit of new bone, or, it may cover the surfaces of the duplicated membrane near the bone; and whenever such arrangement or condition of this tissue takes place, upon the alveolar border, (and that it may, occasionally, we think there can be no question,) it is probable that a new tooth papilla is produced, which, in the progress of

its development, induces the formation of the various appendages necessary to the production of a perfect tooth.

This, in the opinion of the author, is the only way that these fortuitous productions can be accounted for in accordance with true physiological principles. It seems impossible to explain the manner of their formation in any other way. All must admit that the presence of mucous membrane is necessary, and we cannot conceive of any other way by which its presence beneath the general surface of the gums can be accounted for; but if we admit this explanation to be correct, the question is at once solved. We believe it is also owing to the accidental occurrence of a certain arrangement or condition of the mucous membrane concerned in the production of the permanent teeth, consisting, most likely, in the formation of "cavities of reserve" more than are called for by the teeth of this dentition, that the development of supernumerary teeth takes place.

The operations of nature, it is true, are so secretly carried on, that we cannot see the precise *modus operandi* by which they are effected; yet in the development of the various organs and structures of the body, we may see them at the various stages of their growth, and note what precedes their arrival at these various stages in the progress of their formation, and upon which their accretion would seem to be dependent. The periods for the arrival of these stages of development, though somewhat irregular, occur for the most part in normal conditions of the body, at certain fixed epochs. Thus, the papilla of the first temporary molar may usually be seen between the sixth and seventh weeks of intra-uterine existence, but previously to this time a slight groove or depression is observable in the mucous membrane of the part from whence it has its origin. The same is true with regard to the papillæ of all the other teeth, though the time for the commencement of their formation occurs at later periods. The peculiar change which takes place in the arrangement of the mucous tissue here, as well as the periods at which they occur, are doubtless determined by certain stages in the development of other parts, and these, very likely, may determine the established number of teeth in both dentitions.

If the foregoing views which we have advanced be correct, these fortuitous productions are not the result of a mere freak of

nature, as they are sometimes facetiously styled. They are the result of the operation of an established law of the economy; and although, after the completion of the teeth of second dentition, its course is suspended, the occurrence of a similar arrangement or condition of the mucous tissue in the parts in question, will again put it in operation.

PART SECOND.

PHYSICAL CHARACTERISTICS OF

THE HUMAN TEETH AND GUMS,

SALIVARY CALCULUS,

THE LIPS AND TONGUE,

AND THE FLUIDS OF THE MOUTH.

PART SECOND.

CHAPTER FIRST.

GENERAL CONSIDERATIONS.

THE susceptibility of the human body to morbid impressions differs in different individuals. In some, its functional operations are liable to derangement from the most trifling causes; in others, they are less easily disturbed. Nor do the same causes always produce the same results. Their effects are determined by the tendency of the organism and the susceptibility of the part on which they act; both with regard to constitutional and local diseases, this is true of the organism generally and of all its parts separately considered, but of none more than the teeth, gums and alveolar processes. The teeth of some persons are so susceptible to the action of corrosive agents, as to become involved in general and rapid decay, as soon as they emerge from the gums; while those of others, though exposed to the same causes, remain unaffected through life. A similar difference of susceptibility also exists in the parts within which these organs are contained.

With the teeth, these differences of susceptibility to morbid impressions, are implanted in them at the time of their formation, and are the result of the different degrees of perfection in which this process is accomplished. In proportion as these organs are perfect, is their capability of resisting the action of destructive agents increased, and as they are otherwise, it is diminished. This is true of every part of the body; but as the teeth are formed, so they continue through life, if not impaired by disease, except that they gradually acquire a very slight in-

crease of density, whereby their liability to caries is correspondingly lessened.

Not so, however, with the other parts of the body. They may be innately delicate, or imperfectly developed, and afterwards become firm and strong, or be at first healthy and well formed, and subsequently become impaired; and in proportion as they undergo these changes, is their susceptibility to disease increased or diminished. But the teeth are not governed by the same laws, either physical or vital, that regulate the operations of the other parts of the animal economy. Not only the manner of their formation, but their diseases, also, are different. The other tissues of the body, not excepting the osseous, are endowed with recuperative powers, whereby an injury is repaired by their own inherent energies, but the teeth do not possess such attributes.

Assuming these propositions to be true; and that they are, especially those with regard to the teeth, we shall endeavor to show; it becomes an object of considerable importance to discover the signs by which the susceptibility of the human organism to disease may be determined. But to do this, except in so far as the teeth, gums and alveolar processes are concerned, is not our present object; yet, in the prosecution of the task we have undertaken, we shall have occasion to advert to certain constitutional and local tendencies, indicated by the appearance and condition of the teeth and other parts of the mouth.

M. Delabarre affirms, that by an inspection of the teeth, we can ascertain whether the innate constitution is good or bad, and our own observations go to confirm the truth of this opinion; but, as this author adds, these are not the only organs that should be interrogated. The lips, the gums, the tongue, and the fluids of the mouth should also be examined to discover the health of the organism, and ascertain whether the original condition of the constitution has undergone any change.

Those who have not been in the constant habit of closely observing the appearances met with in the mouth, may be sceptical with regard to the information that may thus be derived; but those who have studied them with care, will not hesitate to say, that they are, in many instances, more certain and accurate than any which can be obtained from other physical appearances.

For example—the periods of the dentinification of the different classes of both sets of teeth being known, we are enabled to infer whether the innate constitution be good or bad, from the physical condition of these organs; for as the functions of the organism are at this time healthily or unhealthily performed, will they be perfect or imperfect, or in other words, will their texture be hard or soft.

It is well known to writers on odontology, that the teeth of the child, like other parts of the body, usually resemble those of its parents; so that when those of the father or mother are bad or irregularly arranged, a similar imperfection is generally found to exist in those of the offspring; but this does not necessarily follow, and when it does, it is the result of the transmission of some constitutional impairment, whereby the formative operation of these organs is either disturbed or prevented from being effected in a perfect and healthy manner. The quality of the teeth of the child, therefore, may be said to depend on the health of the mother, and the aliment from which it derives its subsistence. If the mother be healthy, and the nourishment of the child of good quality, the teeth will be dense and compact in their texture, generally well formed and well arranged, and as a consequence less liable to be acted on by morbid secretions than those of children deriving their being from unhealthy mothers, and subsisting upon aliment of a bad quality. Temperament, also, exercises an influence upon the functional operations of the body. Upon it the constitutional health depends to a greater extent than pathologists generally admit, and hence it is, that that of the child usually partakes of that of one or other, or both, of its parents. "This," says M. Delabarre, "is particularly observable in subjects that have been suckled by a mother or nurse whose temperament was similar to theirs." To obviate the entailment of this evil, he recommends mothers, having teeth constitutionally bad, to abstain from suckling, and that this highly important office be entrusted to a nurse having good teeth; asserting at the same time, that by this means, the transmission of so troublesome a heritage as bad teeth may be avoided.

Depending, then, as the physical condition of the teeth and the organism generally, confessedly do, upon the quality of the nourishment from which subsistence is derived during infancy and

childhood, it is highly essential that this be good; and that that, especially, derived from the breast, be from those only who are in the enjoyment of perfect health, and possess good constitutions.

Delabarre says, that a child, though it derives its being from weakly parents, may, by proper regimen, acquire a good constitution and temperament. M. Mahon, a French dentist and author of considerable acumen and celebrity, affirms, that a person cannot be born with a good constitution, unless those from whom he derives his being are in good health, and of that age when life is vigorous. But he admits, that a child coming from parents of the most perfect health, may have its constitution deteriorated by impure lactation: and that a child coming from weakly parents, may acquire a good constitution, though it will always bear about it certain signs of that which it had inherited; and thence, he deduces that it is possible to discover, by an examination of the teeth, any tendencies that may be lurking in the system. He has certainly studied the subject very attentively, and his remarks are worthy of consideration. If all he says is not true, many of his observations, we think, are susceptible of proof.

In treating upon the physiognomical indications of the teeth, the last named author says: "Does the child derive its life from parents that are unhealthy? Then the enamel of its milk teeth will be bad; the teeth, themselves, will be impressed with a bluish tinge, and in a short time, corroded by a humid and putrefying caries. When the parents are only weakly or delicate, the enamel of the primary teeth will have a bluish appearance, there will be a tendency in them to dry caries, which does not ordinarily make much progress, and seldom causes pain."

Again, he observes, "It was only by a determination to notice very accurately the differences which I remarked in the teeth of numerous individuals, that I obtained these primary truths; which in the first instance were little more than mere conjectures, but by being daily increased, have now become diagnostics, about the certainty of which, I flatter myself, I cannot be deceived. It affords me pleasure to give an account in this place of a part of the means which I employed to arrive at the point which was the object of my researches. When I perceived some signs, as for example, shadowy lines on the primary

teeth, and those of replacement, of different children, I put all my application to work for the ascertainment of their cause; and when I believed I had found it, I interrogated their mothers, who generally confirmed the judgment I had formed. I then went on further; after calculations that seemed to me highly probable, I ventured to declare the period at which a great crisis or disease had happened, and in such a month of pregnancy; and I have had the satisfaction to find that I had conjectured correctly. 'My expectations, based upon the same procedure, have been crowned with success in *adults;* whose teeth, by the simple examination of them, have disclosed to me an advantage no less valuable than the first; namely, that of generally being able to tell, whether they were born of strong, weak, or aged parents; and also, if the mother has had several children, whether they were among the last," etc.

That a person experienced in such researches, may, by an examination of the deciduous teeth, tell whether the mother, during the latter periods of pregnancy, had enjoyed good or bad health, there is no question. But it is very doubtful whether much can be ascertained, by an inspection of the milk teeth, concerning the health of the mother previously to the time of the commencement of their solidification, for upon the manner in which this is effected, depends their appearance and physical condition. The density of a tooth may be told at a single glance by a practical observer, and it is this and its color that are principally influenced by the condition of the system during their solidification. The shape of the teeth is determined by that of the jaws and pulps before the commencement of this process.

We are of opinion, therefore, that nothing positive, concerning the health of the mother during the first five or six months of pregnancy, can be learned from an inspection of the teeth of either dentition. From an inspection of those of the second, no information whatever in relation to it can be derived, and if Mahon was fortunate enough in some instances to tell what it had been at an earlier period, his prognosis could not have been founded upon any thing more than mere conjecture.

The teeth while in a pulpy state partake of the health of the organism generally. As that is healthy and strong, or unhealthy and weak, so will the elementary principles of which

they are then composed, be of a good quality, or deteriorated; but after dentinification has commenced, the solid parts cease to be influenced by, or to obey the laws of the other parts of the body. If the general health be good at the time this process is going on, it will be evidenced in their density and color; if bad, in the looseness of their texture, etc.

This is a subject to which we have paid some attention, having for a long time been in the habit of carefully noting the differences in the appearance of the teeth of different individuals, and of both dentitions; and though we have been able to conjecture in some instances what had been the state of the mother's health during the first months of pregnancy, candor compels us to confess, that we have never been able to find any signs in the peculiarity of their shape, size, density, or arrangement, that indicated it. But from the moment that the part of the formative process of these organs, which is not influenced by subsequent changes in the general economy, commences, certain peculiarities of appearance are impressed upon them that continue through life, and about the certainty of the indications of which, in regard to the general health, we think there can be no doubt.

In commenting upon the views which M. Mahon advances upon this subject, Delabarre says,* "if he had thrown the light of repeated dissections upon them, he would have acknowledged, with Hunter, Blake, Maury, Fox and Bunon, that the secondary teeth do not begin to ossify until about the sixteenth month after birth, so that the good or bad health of the parents at the time of conception, cannot in any way affect the teeth of replacement, which are not formed until after the child comes into the world."

But, however vague and erroneous may be some of the opinions of Mahon, he has certainly advanced many that are correct, and from which, hints have been derived that have formed the foundation of some very valuable contributions to the science of the semeiology of the teeth.

Lavater was laughed at and ridiculed for his enthusiastic belief in physiognomy; but the description which he gives, with a view to the illustration of his favorite science, of the physical conformation of the various parts of the face, head, and other portions of the organism of man, embrace signs, which, if applied

* Vide *Semeitique Buccale*, p. 225.

to the study of semeiology, could hardly fail to lead to important results. Had the education and pursuits of this good and extraordinary man, fitted him for the investigation of this department of medical science, and had he entered into it with the same persevering ardor and zeal he did that of physiognomy, he would have erected for himself an equally enduring monument of fame, and would thus perhaps have contributed as much to the amelioration of the condition of his fellows, as he has done by his physiognomical researches. In fact, of the importance of this subject, he seems to have been fully aware; and, after acknowledging his ignorance, he says, the physiognomical and pathognomical semeiotica of health and disease ought to be investigated by an experienced physician, stating, that from the few observations which he had made, it was not difficult to discover the diseases to which an individual in health is most liable. He regards physiognomical semeiotics, founded upon the nature and form of the body, as of great importance to the medical practitioner, that he may be able to say to an individual in health, you may expect this or that disease some time in your life. Possessed of this knowledge, he would be able to prescribe the necessary preventatives or precautions against such diseases as the patient is most liable to contract.

Among the signs which he notes as indicative of the temperament, he enumerates the shape, size and arrangement of the teeth; but from the physical characteristics of these organs, when considered separately from other parts of the mouth, we only learn what the innate constitution is; they cannot be relied upon as indices to the state of the health subsequent to the time of their solidification. Their own liability to disease, however, may be determined by their appearance; therefore, with the signs indicative of this, every dentist should be familiar, so as to enable him, when consulted with regard to the attention necessary to the preservation of these organs, to prescribe such precautionary measures as will secure them against the attacks of disease.

With regard, also, to the information concerning the innate constitution, to be derived from an inspection of the teeth, it has been well remarked by Delabarre, that physicians may derive much advantage in pointing out the rules of domestic hygiene

for the physical education of children; for, says this eminent dentist, "can he admit of but one mode? Has he not, then, the greatest interest in being well assured of the innate constitution of each child, for whom advice is required, to enable him to recommend nutriment suited to the strength of its organs? Will he report only on a superficial examination of the face, its paleness, the color of the skin, all of which are variable? Will he not regard the repletion or leanness of the subject, the state of the pulse, &c.? Surely he will make good inductions from all these things; but the minute examination of the mouth will give him, beyond doubt, the means of confirming his judgment; for, besides what we already know of the teeth, the mucous membrane of the buccal cavity receives its color from the blood, and varies according to the state of that fluid." This is a matter which the observation of the dentist has an opportunity of confirming, almost every day; and which, when taken in connection with the physical characteristics of the teeth, together with those of the salivary and mucous secretions of the mouth, constitute data, from which both the innate and present state of the constitutional health may be determined with accuracy and certainty.

The symptoms of actual disease have been minutely and repeatedly described, but the physiognomical signs by which the susceptibility of the human organism to morbid impressions is determined, and the kind of malady most liable to result therefrom, do not appear to be so well understood. "Whatever," says the author last quoted, "may be the knowledge which a practitioner may acquire of the changes which a disease, or even any tendency to disease, may effect in the functions of some organs, it is, at least, advantageous to be able to conjecture what has happened, in the whole of the system at some other time. In fact, can a physician, when about to prescribe for a slight indisposition of a person whom he hardly knows, rely entirely upon the symptomatology of the tongue? Does not its aspect singularly vary? Is it not notorious, that in certain persons it is always red, white, yellow or blackish? I, as well as others, have had occasion to make these observations on persons with whom it was always thus, yet without their being subject to any of those indispositions that are so common in the course of life." These signs are as variable in sickness as in health, and, conse-

quently, can only be relied upon as confirmatory of the correctness of other indications which manifest themselves in other parts of the body.

The physical changes produced by, and characteristic of, disease have been described, both by ancient and modern medical writers, but the works which have appeared upon this subject do not comprise all that is necessary to be known. For example—if we examine the lips, tongue and gums of a dozen or more individuals who are regarded as in health, differences in their appearance and condition will be found to exist. The lips of some will be red, soft and thin; others red, thick and of a firm texture; some will be thin and pale; others red on the inside and pale on the edges; some are constantly bathed with the fluids of the mouth; others are dry: and these differences of appearance and condition are as marked on the tongue and gums as they are upon the lips, and are supposed to be attributable to the preponderance or want of existence in sufficient quantity of some one or more of the elementary principles of the organism. Hence, may be said to result the differences in temperament and susceptibility of the body to the action of morbid excitants.

The body, says Lavater, is composed, after an established manner, "of varying congruous and incongruous ingredients." He also believes "that there is," to use the metaphor, "a particular recipe, or form of mixture, in the great dispensatory of God, for each individual, by which his quantity of life, his kind of sensation, his capacity and activity are determined; and that, consequently, each body has its individual temperament, or peculiar degree of irritability. That the humid and the dry, the hot and the cold, "are the four principal qualities of the corporeal ingredients, is as undeniable as that earth and water, fire and air, are themselves the four principal ingredients." Hence, he argues, "that there will be four principal temperaments; the choleric, originating from the hot; the phlegmatic, from the moist; the sanguine, from air; and the melancholic, from earth; that is to say, that these predominate in, or are incorporated with, the blood, nerves and juices, and indeed in the latter, in their most subtile, and almost spiritually active form. But it is equally indubitable to me, that these four temperaments are so intermingled that innumerable others must arise, and that it is

frequently difficult to discover which preponderates; especially since, from the combination and interchangeable attraction of those ingredients, a new power may originate, or be put in motion, the character of which may be entirely distinct from that of the two or three intermingling ingredients." The truth of these propositions will hardly be questioned, and their admission at once affords a satisfactory explanation of the differences in the susceptibility of different organisms to the attacks of disease.

Admitting the foregoing statement to be correct, we think it may be safely assumed, that if the quality and respective proportions of the materials furnished for the growth, reparation and maintenance of the several organs of the body, be good, and in proper proportion, all the organs will be well formed and endowed with health, and, as a consequence, capable of performing their respective functions in a healthy manner. But if their elementary ingredients, to use an expression of the author from whom we have just quoted, be bad, their functions will be more or less feebly performed.

These materials are furnished by the blood.* From this fluid, each organ receives such as are necessary to its own particular organization. The blood, therefore, exercises an important influence upon the whole system, determining the health of all its parts; which, as Delabarre says, "is relative to the quality of the blood, and the general health results from that of all parts of the system." In order to this, harmony must exist between all the organs, but in consequence of the great variety and intermingling of temperaments it rarely does, except, perhaps, in those in whom the sanguine predominates, and who have not become enervated by irregular and luxurious living. Even when it does exist, we are by no means certain that it will continue to do so; for, exposed as the body is to a thousand causes of disease, its functional operations may, at almost any moment, become disturbed. Among the civilized nations of the earth, the peasantry of Great Britain, probably, possess as good constitutional temperaments as are anywhere to be found; and yet, with these people, we are told, that although the sanguineous pre-

* Of the various writers who have treated upon this fluid, Magendie ranks deservedly high. He instituted a great variety of experiments upon animals, which go to prove, conclusively, that no one of its constituents can be dispensed with without manifest and serious injury to the whole organism.

dominates in a majority of cases, it is combined and intermingled, in a greater or less degree, with others.

In all of these modifications the blood plays an important part: it determines the temperament of the individual, and by consequence, the physical condition of all the tissues of the body subject to the general laws of the economy. But the dependence between the solids and this fluid is mutual; it, also, is dependent upon them, and the condition of the one is relative to that of the other. The solids, if we may be permitted the use of the metaphor, are the distillery of the fluids, while they, in turn, nourish, repair, and maintain the solids. A change, then, in the condition of one, is followed by a corresponding change in the condition of the other. If the blood be of an impure quality, or any of the ingredients entering into its composition exist in too great or too small quantity, it will fail to supply the solids with the materials necessary to the healthful performance of their functions, and, if not actual disease, a tendency to it, will be the result. And, again, the purity of the blood is dependent upon the manner in which the solids perform their offices. While, therefore, duly appreciating the importance of this fluid, and its existence in a pure state, to the general health of the economy, we cannot ascribe to it, regardless of the functions of the solids, a controlling influence over the organism.

To distinguish all the nice and varied shadings of temperament, or states of the constitutional health, by the physiognomical appearances of the body, is perhaps impossible, or can only be done with great difficulty, and by those who have been long exercised in their observance; but to discover that which predominates is not so difficult a matter, and the indications are nowhere more palpably manifested than in the mouth. By an inspection of the several parts of this cavity, together with its fluids and the earthy matter found upon the teeth, we believe, inductions may be made, not only with regard to the innate constitution, but also with regard to the present state of health, serviceable both to the dental and medical practitioner; and, in the further prosecution of this inquiry, we shall endeavor to point out some of the principal of the indications here met with, to state the appearances by which they are distinguished, and to offer such other general reflections as the subject may, from time to time, seem to suggest.

CHAPTER SECOND.

PHYSICAL CHARACTERISTICS OF THE TEETH.

Most dental physiologists have observed the marked differences that exist in the appearances of the teeth, gums, lips, tongue, and secretions of the mouth of different individuals; and of that earthy substance, (commonly called tartar,) deposited in a greater or less abundance on the teeth of every one; and though all may not have sought their etiology, many have had occasion to notice, at least, their local indications, and to profit by the information which they have thus obtained. Nor have they failed to observe that the size, color, length and arrangement of the teeth vary, and that these are indicative of their susceptibility to disease.

There are five principal classes or descriptions of teeth, each of which differs, in some respects, from the others.

Class First.—The teeth belonging to this class are white, with a light cream colored tinge near the gum, which becomes more and more apparent as the subject advances in age, of a medium size, rather short than long; those of each class of uniform dimensions, and very hard. This description of teeth is most frequently met with in persons of sanguineous temperament, or, at least, those in whom this predominates; they rarely decay, and indicate, if not *perfect* health, at least a state which bordered very closely on it at the time of their dentinification.

This first description of teeth is occasionally found among persons of all nations. They are very common, especially in the middle classes of the inhabitants of England, Ireland and Scotland. They are also frequently met with in some parts of the United States, the Canadas, the mountainous districts of Mexico, and so far as we have had an opportunity of informing ourself, in France, Russia, Prussia and Switzerland. Those who have them usually enjoy excellent health, and are seldom troubled

with dyspepsia or any of its concomitants. It is this kind of teeth which, Lavater says, he has never met with, except in "good, acute, candid, honest men," and of whose possessors it has been remarked, that their stomachs are always willing to digest whatever their teeth are ready to masticate.

In confirmation of what has before been said with regard to the influence which the state of the constitutional health, at the time of the solidification of the teeth, exerts upon the susceptibility of these organs to morbid impressions, it is only necessary to mention the fact, well known and frequently alluded to, of the early decay of a single class, or a pair of a single class of teeth, in each jaw, while the rest, possessing the characteristics just described, remain sound through life. Thus when it happens that a child, of excellent constitution, is affected with any severe disease; the teeth which are at the time receiving their earthy salts, are found, on their eruption, to differ from those which have received their solid material at another time, when the operations of the body were healthfully performed. Instead of having a white, smooth and uniform surface, they have a sort of chalky aspect, or are faintly tinged with blue, and are rougher and less uniform in their surfaces. Teeth of this description are very susceptible to the action of corrosive agents, and, as a consequence, rarely last long.

But, not willing to rest the correctness of these views upon mere hypothesis, we, in a great number of instances, where we have seen teeth thus varying in their physical appearance, have taken pains to inquire of those who had an opportunity of knowing the state of the general health of the individuals, at the different periods of dentinification; and in every case where we have been able to procure the desired information, it has tended to the confirmation of the opinion here advanced. Nor have we neglected to improve the many opportunities that have presented, in the course of a somewhat extended professional career, of making these observations.

Although the operations of the economy are so secretly carried on, that it is impossible to comprehend their details fully, it is known that the phenomena resulting therefrom are influenced and modified by the manner in which they are performed. If they are deranged, the blood, from which the earthy

materials forming the basis of all the osseous tissues are derived, is deteriorated, and furnishes these salts in less abundance and of an inforior quality. Hence, teeth that solidify when the system is under the influence of disease, do not possess the characteristics necessary to enable them to resist the assaults of corrosive agents, to which all teeth are more or less exposed, and which rarely affect those that receive their solidifying ingredients from pure blood.

The calcareous salts of these organs are furnished chiefly by the red part of this fluid, the gelatine is derived from the white or serous part;—"whence," as Delabarre remarks, "it results that the solidity of these bones varies according as one or other of these principles predominates," and the relative proportions of these are regulated by the state of the blood at the time the teeth are undergoing solidification.

The researches of DUHAMEL show, that bones acquire solidity no faster than the parts which are about to ossify become charged with red blood. The experiments of HALLER are also confirmatory of this opinion. And Delabarre, in remarking upon the dentinification of the teeth, says, "the superficial layer of the pulp reddens before it ossifies, whilst all below is entirely white; soon another layer reddens, is ossified, and then whitens, and so on, successively."

The increase of density which the teeth continue through life very gradually to acquire, may seem to militate somewhat against this theory, as the fluid conveyed to the dentine subsequent to solidification is not even so much as tinged with red; but it is a probability amounting to certainty, that the fluid derived from the pulp and circulating in the dentinal tubuli, is abundantly sufficient to maintain the integrity of the dentine, or even to contribute to the condensation of that substance.

Class Second.—Having digressed thus far, we shall now proceed to notice the teeth belonging to the second class. They have a faint, azure blue appearance; are rather long than short; the incisors are generally thin and narrow; the cuspids are usually round and pointed; the bicuspids and molars small in circumference, with prominent cusps and protuberances upon their grinding surfaces. In some cases the lateral incisors are very small and pointed.

Teeth possessing these characteristics are usually very sensitive, more easily acted upon than teeth of the first class by corrosive agents, and to the ravages of which, unless great attention is paid to their cleanliness, they often fall early victims. They are more frequently affected with atrophy, or have upon their surfaces white, brown or opaque spots, varying in size and number; several are sometimes found upon a single tooth, and in some instances every tooth in the mouth is more or less marked with them.

But this is not the only description of teeth liable to be affected with this disease. These spots are occasionally met with on teeth of every degree of density, shape, shade and size, but they are, probably, more frequently seen on teeth of the second class than on those first described; besides which it often happens that they are affected with erosion on emerging from the gums, and sometimes so badly as to place either their restoration and preservation beyond the reach of art. This species of erosion, or that which occurs previously to the eruption of the teeth, is caused by some diseased condition of the fluid which surrounds them before they appear above the gums, and is denominated congenital.

Teeth like those now under consideration, are indicative of a weakly constitution, of a temperament considerably removed from the sanguineous, and of blood altogether too serous to furnish materials such as are necessary for building up a strong and healthy organism. They are more common to females than males, though many of the latter have them. They are met with among people of all countries, but more frequently among those who reside in sickly localities, and with individuals whose systems have become enervated by luxurious living. In Great Britain they are more rare than in the United States, and those who have them seldom attain to a great age. Nevertheless, some, under the influence of a judicious regimen, and a salubrious climate, though innately delicate, do acquire a good constitution, and live to a great age ; while the teeth, less fortunate, unless the most rigid and constant attention is paid to the use of the means necessary for their preservation, generally fall early victims to the ravages of disease.

Class Third.—The teeth of this class, though differing in

many of their characteristics from those last described, are, nevertheless, not unlike them in texture and sensibility to disease. They are larger than teeth of the first or second class; their faces are rough and irregular, with protuberances arising, not only from the grinding surfaces of the bicuspids and molars, but also, not unfrequently, from their sides, with correspondingly deep indentations. They have a muddy white color. The crowns of the incisors of both jaws are broad, long and thick. The posterior or palatine surfaces of those of the superior maxilla are rough, and usually deeply indented. In the majority of cases their arrangement is quite regular, though frequently found to project. The alveolar ridge usually describes a broad arch. The excess in size, both here and in the teeth, seems to consist more of gelatine than calcareous phosphate. This description of teeth decay readily, and in some instances appear to set at defiance the resources of the dentist. They are liable to be attacked at almost every point, but more particularly in their indentations and approximal surfaces.

The author is acquainted with a family, consisting of seven or eight members, most of whom are adults, all having this sort of teeth. The most thorough attention has been paid by each, and yet all have lost most of their teeth. They are usually first attacked in their approximal surfaces and indentations, but neither their labial faces nor most prominent points are exempt from caries. No sooner is its progress arrested in one place or part than it appears in another. The author has had occasion to fill a single tooth in as many as four, five, and even six different places; and in this way, though his efforts at the preservation of any considerable number have proved unavailing, he has been able to save some of them. But it is not necessary to particularize cases. Every dentist has seen teeth of this description.

The corrosive properties of the fluids of the mouth, however, are sometimes so changed by an amelioration of the constitution, that notwithstanding the great susceptibility of the teeth to disease, they are sometimes preserved to a late period of life, or until the general health relapses into its former, or some other unfavorable condition. This has happened in several instances that have come under the author's immediate observation, and

it should be borne in mind that the solvent qualities of these juices are influenced by the state of the constitutional health.

Class Fourth.—Teeth of this class usually have a white chalky appearance, are unequally developed, and of a very soft texture. They are easily acted upon by corrosive agents, and like the teeth last noticed, generally fall speedy victims to disease, unless great care is taken to secure their preservation.

Persons who have teeth such as described in classes three and four, generally have what Laforgue calls lymphatico-serous temperaments. Their blood is usually pale, the fluids of the mouth abundant, and for the most part exceedingly viscid. They do not have that white frothy appearance observable in healthy, sanguineous individuals.

As teeth that are neither too large nor too small, and that have a close, compact texture, and tinged with yellow, are indicative of an originally good constitution, whatever it may be at the present time; so those which are long, narrow, and faintly tinged with blue, as well as those that greatly exceed the ordinary size, and that are irregular in shape, and have a rough, muddy appearance, furnish assurance of a constitution originally bad. The first of the latter descriptions of teeth are more frequently met with among females than males, and among those of strumous habit, than those in whom this diathesis does not exist.

Class Fifth.—The teeth belonging to this class are characterized by whiteness and a pearly gloss of the enamel. They are long, and usually small in circumference, though sometimes well developed. They are regarded by many as denoting a tendency to phthisis pulmonalis, and are supposed by some to be very durable; but the author has observed that individuals who have this sort of teeth, when attacked by febrile or any other form of disease having a tendency to alter the fluids of the body, are very subject to tooth-ache and caries; and that when this condition of the general system is continued for a considerable length of time, the teeth, one after another, in rapid succession, crumble to pieces.

It would seem from this circumstance, that the fluids of the

mouth in subjects of strumous habit, if free from other morbid tendencies, are less prejudicial to the teeth than they are in most other constitutions, and the author is of the opinion that it is owing to this that they are so seldom attacked by caries.

M. Delabarre believes, that caries supervenes upon this disease, and is a consequence of the general debility engendered by it. Now, this is directly opposed to all observation on the subject, for it is well known that teeth are less affected by this disease than almost any other, and it is unfortunate for the doctrine, which he in another place advocates—that the solid tissue of these organs is softened by the arteries ceasing to supply it with calcareous materials—that he should have resorted to this argument. Its absurdity is rendered apparent by his own showing, and that, too, in the paragraph succeeding the one in which the argument is used. He says, "Whatever may be the diseased condition of the teeth, they may be examined as unexceptionable evidence, that will inform us whether the patient owes his present state of health to a predisposition, or whether, having supervened during the course of his life, it depends on an accidental cause."

If the state of the health, subsequent to dentinification were capable of diminishing or increasing the density of these organs, we could learn nothing by inspection of the primordial constitution. Nor would we, therefore, be able to determine whether the present state of health were the result of constitutional predisposition, or of some other cause; for, if the teeth were subject to changes, like other parts of the body, their physical condition might be different to-day from what it was yesterday, and a diagnosis, founded upon their appearance, would be nothing more than mere vague conjecture.

But, although Delabarre is in many things somewhat inconsistent, a number of his views are correct; and few men have contributed more largely, by observation and experience, to the advancement of the science of the teeth than he has done.

In speaking of persons who have teeth, which, though beautiful from having smooth and apparently polished surfaces, present shades intermixed with a dirty white, he says, they "have had alternations of good and indifferent health during the formation of the enamel. These teeth," he continues, "ordi-

narily have elongated crowns, and many present marks of congenital atrophy." Again, he observes, "Teeth of this sort deceive us by appearing more solid than they are; they remain sound until about the age of fourteen or eighteen; at this period a certain number of them decay, especially when in infancy the subject was lymphatic, and continued to be so in adolescence. This description of teeth is frequently met with among the richer classes, in which children born feeble, reach puberty only by means of great care, and, consequently, owe their existence solely to the unremitting attention of their parents, and the strengthening regimen that the physician has caused them constantly to pursue. Having reached the eighteenth or twentieth year, their health is confirmed, but the mucous membranes ever after have a tendency to be affected; the redder color of the mouth, more especially its interior part, and that of the lips, and the upper part of the palate, which, by degrees, discovers itself as the subject gradually advances in years, showing an ameliorated condition. It is thus that numerous persons, having gained a sanguineous temperament, would deceive us; if it were not that some marks of erosion are seen on the masticating surfaces of the first permanent molars, which informs us that the present health is the result of amelioration."

There are other cases in which the teeth are of so inferior a quality, that they no sooner emerge from the gums than they are attacked and destroyed by caries; while the subjects who possess them, are enabled, by skillful treatment, to overcome the morbid constitutional tendencies, against which, during the earlier years of their existence, they had to contend, and eventually, to acquire excellent health. But in forming a prognosis, it is essential to ascertain whether the general organic derangement which prevented the teeth from being well formed, and thus gave rise to their premature decay, is hereditary, or whether it has been produced by some accidental cause subsequent to birth. The procurement of health in the former case will be less certain than in the latter, for when the original elements of the organism are bad, the attainment of a good constitution is more difficult.

Persons of sanguineo-mucous temperaments, having suffered in early childhood from febrile or inflammatory diseases, often

have their teeth affected with what Duval calls the decorticating process (denudation of their enamel), resulting, no doubt, from the destruction of the bond of union between it and the dentine.

There are other characteristics which the teeth present in shape, size, density, and color, and from which valuable inductions might be made, both with regard to the innate constitution and the means necessary to their own preservation; but as the limits assigned to this part of our subject will not admit of their consideration, we shall conclude by observing, that the appearances of these organs vary almost to infinity. Each is indicative of the state of the general health at the time of their formation, and of their own physical condition and susceptibility to disease.

CHAPTER THIRD.

PHYSICAL CHARACTERISTICS OF THE GUMS.

Little can be ascertained concerning the intimate constitution from an inspection of the gums. Subject to the laws of the general economy, their appearance varies with the state of the general health and the condition and arrangement of the teeth. Although the proximate cause of disease in them may be specified as local irritation—produced by depositions of tartar upon the teeth, or decayed, dead, loose or irregularly arranged teeth, or by a vitiated state of the fluids of the mouth, resulting from general organic derangement, or any or all of the first mentioned causes—their susceptibility to morbid impressions is influenced to a considerable extent by the constitutional health; and the state of this determines, too, the character of the morbid effects produced upon them by local irritants. For example, the deposition of a small quantity of tartar upon the teeth, or a dead or loose tooth, would not, in a healthy person, of a good constitution, give rise to anything more than slight increased vascular action in the margin of the gums in contact with it; while in a scorbutic subject, it would cause them to assume a dark purple appearance for a considerable distance around, to become swollen and flabby, to separate and retire from the necks of the teeth, or to grow down upon their crowns, to ulcerate and bleed from the slightest injury, and to exhale a fetid odor. In proportion as this disposition of body exists, their liability to be thus affected is increased; and it is only among constitutions of this kind that that peculiar preternatural morbid growth takes place, by which the whole of the crowns of the teeth sometimes become almost entirely imbedded in their substance.

But, notwithstanding the dependence of the condition of the gums upon the state of the constitutional health, they are occasionally affected with sponginess and inflammation in the best temperaments, and in individuals of uninterrupted good health.

The wrong position of a tooth, by causing continued tension of the gums investing its alveolus, sooner or later gives rise to chronic inflammation in them and the alveolo-dental periosteum, and gradual wasting of their substance about the mal-placed organ. The causes of tooth-ache, too, often produce the same effects; the accumulation of salivary calculus upon teeth, however small the quantity, is likewise prejudicial.

All of these may occur independently of the state of the general health. A bad arrangement of the best constituted teeth, and tooth-ache may be produced by a multitude of accidental causes, disconnected with the functional operations of other parts of the body.

While, therefore, the appearance and physical condition of this peculiar and highly vascular structure are influenced in a great degree by habit of body, they are not diagnostics that always, and with unerring certainty, indicate the pathological state of the general system. It can, however, in by far the larger number of cases, where the gums are in an unhealthy condition, be readily ascertained whether the disease is altogether the result of local irritation, or whether it is favored by constitutional tendencies.

In childhood, or during adolescence, when the formative forces of the body are all in active operation, and the nervous susceptibilities of every part of the organism highly acute, the sympathy between the gums and other parts of the system, and particularly the stomach, is, perhaps, greater than at any other period of life. The general health, too, at this time is more fluctuating, and with all the changes this undergoes, the appearances of the gums vary. Moreover, there are operations carried on beneath and within their substance, which are almost constantly altering their appearance and physical condition; and which, being additionally influenced by various states of health and habits of body, it may readily be conceived that those met with in one case, might be looked for in vain in another.

Having arrived at that age when all the organs of the body are in full vigor of maturity, and not under the debilitating influences to which they are subject during the earlier periods of life, the gums participate in the happy change, and as a consequence, present less variety in their characteristics. The gene-

ral irritability of the system is not now so great, the gums are less susceptible to the action of irritating agents, and as a consequence, less frequently affected with disease; but as age advances, and the vital energies begin to diminish, the latent tendencies of the body are re-awakened, and they are again easily excited to morbid action.

In the most perfect constitutions, and during adolescence, they present the following appearances: they have a pale rose-red color, a firm consistence, a slightly uneven surface; their margins form along the outer surfaces of the dental circle beautiful and regular festoons, and the mucous membrane, here, as well as in other parts of the mouth, has a fresh, lively, roseate hue.

The time for the moulting of a primary tooth is announced some weeks before it takes place, by increased redness and slight tumefaction of the edges and apices of the gums surrounding it. The eruption of a tooth, whether of the first or second set, is also preceded by similar phenomena in the gums through which it is forcing its way, and these will be more marked as the condition of the system is unhealthy, or as the habit of body is bad.

If the health of the subject continues good, and the teeth are well arranged, and the necessary attention to their cleanliness be strictly observed, the characteristics just enumerated will be preserved through life, except there will be a slight diminution of color in them, after the age of puberty until that of the climacteric period of life, when they will again assume a somewhat redder appearance. But if the health of the subject becomes impaired, or the teeth be not regularly arranged, or wear off, or are not kept free from all lodgment of extraneous matter, their edges, and particularly their apices, will inflame, swell, and become more than ordinarily sensitive.

The gradual wasting or destruction of the margins of the gums around the necks of the teeth, which sometimes takes place in the best constitutions, and is supposed by some to be the result of general atrophy, is ascribable, we have no doubt, to some one or other of these causes; favored, perhaps, by a diminution of vitality in the teeth, whereby they are rendered more obnoxious to the more sensitive and vascular parts within which their roots are situated. That these are the causes of the affec-

tion, (for it is evidently the result of diseased action in the gums,) is rendered more than probable, by the fact, that it rarely occurs with those who, from early childhood, have been in the regular and constant habit of thoroughly cleansing their teeth from four to five times a day.

Mr. Bell, however, while he thinks it may occasionally be an "indication of a sort of premature old age," does not believe it can "always be thus accounted for, as it is sometimes seen in young persons," and "doubtless arises," he says, "from the same causes as those presently to be considered," (alluding to what he afterwards says upon the same subject,) "as occasioning a similar loss of substance in these parts, when attended with more or less of diseased action." We cannot, for reasons already assigned, concur with him in the opinion that it "occasionally takes place without any obvious local or constitutional morbid action."

Although possessed of a good constitution, a person may, by intemperance, debauchery, or long privation of the necessary comforts of life, or by protracted febrile or other severe kinds of disease, have his assimilative and all the other organs of the body so enervated, as to render every part of the system highly susceptible to morbid impressions of every sort; but still, this general functional derangement rarely predisposes the structure now under consideration, to any of the more malignant forms of disease occasionally known to attack it in subjects possessed of less favorable constitutions. The margins of the gums may inflame, become turgid, ulcerate, and recede from the necks of the teeth, and the whole of their substance be involved in an unhealthy condition; but they will seldom be attacked with scirrhous or fungous tumors, or bad conditioned ulcers, or affected with preternatural morbid growths; and in the treatment of their diseases, we can always form a more favorable prognosis in persons of this description, than those coming into the world with some specific morbid tendency.

But the occurrence of severe constitutional disease, even in these subjects, is followed by increased irritability of the gums; so that the slightest cause of local irritation gives rise to an afflux of blood to, and stasis of this fluid in, their capillaries.

The teeth of persons thus happily constituted, are endowed

with characteristics, such as have been represented as belonging to those of the best quality. They are of a medium size, both in length and volume, white, compact in their structure, generally well arranged, and seldom affected with caries.

Another constitution is observed, in which the gums, though partaking somewhat of the characteristics just described, differ from them in some particulars. Their color is of a deeper vermilion; their edges rather thicker, their structure less firm, and their surface not so rough, but more humid. The mucous membrane has a more lively and animated appearance. They are more sensitive and more susceptible to the action of local irritants, with morbid tendencies more increased by general organic derangement, than when possessed of the appearances first mentioned.

When in a morbid condition, the disease, though easily cured by proper treatment, is, nevertheless, more obstinate, and when favored by constitutional derangement, assumes a still more aggravated form. Their predisposition to disease is so much increased by long continued disturbance of the general system, and especially during youth, and by febrile or inflammatory affections, that not only their margins, but their whole substance, sometimes become involved in inflammation and sponginess, followed by ulceration of their edges, and recession from the necks of the teeth, which, in consequence, loosen, and often drop out. But gums of this kind, like those first described, seldom grow down upon the crowns of the teeth. Neither are they very liable to be attacked with scirrhous or fungous tumors, or any form of disease resulting in sanious or other malignant-conditioned ulcers. Indeed, with diseases of this kind, they are not, perhaps, ever affected, except in those cases where every part of the body has become exceedingly depraved by intemperance, debauchery, or some other cause.

The teeth of those whose gums are of this description, if well arranged and kept constantly clean, and, if the secretions of the mouth be not vitiated by general disease, will, in most cases, remain healthy through life.

It is only among sanguineous persons that this description of gums is met with, and the teeth of subjects of this kind are generally of excellent quality, and though more liable to be attacked

by caries than those first noticed, they are seldom affected with it.

In sanguineo-serous and strumous subjects, the gums are pale, and though their margins are thin and well festooned, often exude, after the twenty-fifth or thirtieth year, a small quantity of muco-purulent matter, which, on pressure, oozes from between them and the necks of the teeth. Their texture is usually firm, and they are not very liable to become turgid. They often remain in this condition to a late period of life, without undergoing any very perceptible change. Their connection with the necks of the teeth and alveolar processes appears weak, but they rarely separate from them.

In remarking upon individuals having such constitutions, M. Delabarre says, that if they "abuse their physical powers," by an injudicious regimen, or too much study, they become enervated and "are subject to chronic sanguineous obstructions of the capillaries of the lungs, and to profuse hemorrhages." Dyspepsia, chronic hepatitis, and diseases in which the *primœ viœ* generally are more or less involved, are not unfrequent, and are indicated by increased irritability, and sometimes, a pale yellowish appearance of the gums. In jaundice, the yellow serosity of the blood is very apparent in the capillaries of this structure.

These constitutions are more common in females than males, in the rich than the poor, and in persons of sedentary habits than in those who use invigorating exercise. If at any time during life the health is ameliorated, the gums assume a fresher and redder appearance, and the exudation of muco-purulent matter from between them and the necks of the teeth ceases.

In mucous dispositions, the gums have a smooth, shining appearance, and are rather more highly colored than the preceding. Their margins, also, are thicker, more flabby, and not so deeply festooned; they are more irritable, and, consequently, more susceptible to morbid impressions.

If, with this disposition, there be combined a scorbutic or scrofulous tendency, the gums during early childhood, in subjects which, from scanty and unwholesome diet, have become greatly debilitated, are liable, besides the ordinary forms of disease, to another—characterized by their separation from, and exfoliation

of, the alveolar processes, accompanied by a constant discharge of sanies. This form of disease, however, though peculiar to childhood, and wholly confined to the indigent, is by no means common.

These constitutions are rarely met with, except amoug persons who live in cellars, and damp and closely confined rooms in large cities, and in low, damp, and sickly districts of country. The mucous membrane in subjects of this kind is exceedingly irritable, and secretes a large quantity of mucus.

In alluding to this species of disposition, M. Delabarre says, "in children, the skin is ordinarily white and tender; nevertheless, it is sometimes brown and wrinkled. They are usually fragile and weak; their blood is pale, their nutrition is imperfectly effected. In females, about the age of puberty, the vertebral column is disposed to curve, because," says he, "at this period, the vital energies are principally directed toward the uterus, and, in consequence, although so very necessary in the osseous system, they appear to be weak.

"The number of observations that I have collected during my practice in the city, and in several public institutions, have confirmed me in the opinion, that it is in this constitution, especially," (alluding to the mucous,) "that the children of whom we have just spoken, are met with. The *organic life* in them has so little energy, that a local cause on a certain point, operates with greater activity than it would otherwise do, sensibly diminishing the assimilative force at almost all other points. It is also probable, that the development of ganglionic obstructions during dentition, are, many times, owing to the diminution of the sensibility in the lymphatics."

"We may also remark," says he, "that, their skin being very susceptible, the sympathy established between it and the mucous membrane, renders individuals of this kind very liable to contract rheums, and gastric and intestinal affections; they are, likewise, subject to easy night sweats, and vomitings of a sero-mucous fluid," etc.

Persons even thus unhappily constituted, do, sometimes, by change of residence and judicious regimen, acquire tolerably good constitutions. Little advantage, however, is derived from these, unless they are had recourse to before the twenty-fifth or

thirtieth year of age, though they may prove beneficial at a much later period.

The gums, in scorbutic persons, have a reddish brown color; their margins are imperfectly festooned, and thick; their structure rather disposed to become turgid, and ever ready, on the presence of the slightest cause of local irritation, to take on a morbid action. When thus excited, the blood accumulates in their vessels, where, from its highly carbonized state, it gives to the gums a dark, purple, or brown appearance; they swell, and become spongy and flabby, and bleed from the slightest touch. To these symptoms, supervene—the exhalation of a fetid odor, the destruction of the bond of union between them and the necks of the teeth, suppuration and recession of their margins from the same, gradual wasting of the alveolar cavities, loosening, and not unfrequently, the loss of several, or the whole of the teeth. These are the most common results, but, sometimes, they take on other and more aggravated forms of diseased action. Preternatural prurient growths of their substance, fungous and scirrhous tumors, ichorous and other malignant, ill-conditioned ulcers, etc.

The occurrence of alveolar abscess in dispositions of this kind is often followed by necrosis and exfoliation of portions of the maxillary bone, and the effects which result to the gums are always more pernicious than in habits less depraved.

The development of the morbid changes which take place in this structure, even in subjects of this kind, while the character of the disease is influenced, if not determined, by a specific constitutional tendency, is, nevertheless, referable to local irritation as the immediate or proximate cause, and, were this the proper place, we could cite numerous cases tending to establish the truth of this opinion.

In scrofulous habits, the gums have a pale bluish appearance, and when subjected to local irritation, they become flabby, exhale a nauseating odor, detach themselves from the necks of the teeth, and their apices grow down between these organs. The blood circulates in them languidly, and debility seems to pervade their whole substance. They are exceedingly irritable, and not unfrequently take on aggravated forms of disease, and, as often happens to this, as well as to the preceding habit, there are com-

bined tendencies which favor the production of ill-conditioned tumors and ulcers.

The indications furnished by the gums during the existence of a mercurial diathesis of the system, are, morbid sensibility, increased vascular and glandular action, foulness, bleeding from the most trifling injuries, pale, bluish appearance of their substance, turgidity of their apices and sloughing. The effects, however, resulting to these parts from the employment of mercury differ in different individuals according to the general constitutional susceptibility, the quantity taken into the system, and the length of time its use has been continued. In persons of very irritable habits, a single dose will sometimes produce ptyalism, and so increase the susceptibility of the gums, that the secretions of the mouth, in their altered state, will at once rouse up a morbid action in them.

The effects of a mercurial diathesis upon these parts, is not unfrequently so great as to result in the loss of the whole of the teeth. But with these effects both the dental and medical practitioner are too familiar to require any further description.

Finally, we would observe, that the indications of the several characteristics to which we have now briefly alluded, may not be correct in every particular, and there are others which we have not mentioned; yet we think they will commonly be found true. As a general rule, persons of a full habit, though possessed of mixed temperaments and in the enjoyment of what is usually called good health, have gums well colored, with rather thick margins, and very susceptible to local irritation. With this description of individuals, inflammation, turgidity, and suppuration of the gums are very common. To prevent these effects, constant attention to the cleanliness of the teeth is indispensable.

Professor Schill says, the "gum is pale in chlorosis and anæmia; of a purple red color before an active hemorrhoidal discharge, and in cases of dysmenorrhœa; of a dark red color, spongy, and bleeding readily in scurvy and diabetes mellitus, and after the use of mercury. Spongy growths indicate caries of the subjacent bone."*

Regular periodical bleedings of the gums in dysmenorrhœa,

* *Outlines of Pathological Semeiology*, page 168, of the Select Medical Library edition.

and particularly in scorbutic and mucous subjects, are not unfrequent, nor in any case where they are in a turgid condition.

Spongy growths of the gums in scorbutic and scrofulous persons, often result from irritation produced by decayed teeth, and are not, therefore, always to be regarded as an indication of caries of the subjacent bone.

Dr. T. Thompson, of London, says, that the reflected margin of the gums of a large majority of phthisical patients, is deeper in color than the other portions, usually presenting a vermilion tint.*

Mr. George Waite says, "A change of residence to a damp climate will often rouse up in the gums a great degree of vascularity. In the damp places of England and Ireland the appearances which the gums present are of a turgid and vascular nature. In the damp countries of France, these conditions of the gums run a much greater length from the circumstance of the difference in the constitutions of the two nations. In the damps of Germany and Switzerland, persons also lose their teeth early in life, the climate engenders malaria and low fevers, enfeebles the power of digestion, and brings on rheumatic affections with languor and general constitutional debility."

Of the correctness of Mr. Waite's observations there can be no question, and they go to establish what has been said in regard to the predisposing cause of disease in the gums; namely, that the enervation of the vital powers of the body, from whatever cause produced, increases their susceptibility to morbid impressions.

* Clinical Lectures on Pulmonary Consumption, p. 117.

CHAPTER FOURTH.

PHYSICAL CHARACTERISTICS OF SALIVARY CALCULUS.

The color, consistence, and quantity of salivary calculus or tartar, as it is most commonly called, vary in different temperaments, and upon all of them the state of the general health exercises considerable influence. The characteristics of this substance, therefore, furnish diagnoses, important both to the physician and dentist. Their indications are in many cases less equivocal than the appearances of any other part of the mouth; but, like those of the gums, should not perhaps, be alone relied upon. It is necessary to interrogate every part from which information can be derived concerning the pathological condition of the several organs of the body.

Salivary calculus is composed of earthy salts and animal matter. Phosphate of lime and fibrine, or cartilage, are its principal ingredients; a small quantity of animal fat, however, enters into its composition, and the relative proportions of its constituents vary accordingly as it is hard or soft, or as the temperament of the individual from whose mouth it is taken, is favorable or unfavorable to health; hence it is, that the analyses that have been made of it by different chemists, differ. No two give the same result.

The black, dry tartar, deposited around the necks of the teeth of such only as have good constitutions, is never in large quantity; it is dissolved in muriatic acid with difficulty, while the dry light brown tartar found upon the teeth of bilious persons, dissolves more readily in it; but the soft white tartar, found upon the teeth of individuals of mucous temperaments, is scarcely at all soluble in the acids, but is readily dissolved in the alkalies.*

All persons are subject to salivary calculus, but not alike; it collects on the teeth of some in larger quantities than on those of others, and its chemical and physical characteristics are ex-

* See M. Delabarre's Traité de la Seconde Dentition.

ceedingly variable. It is, sometimes, almost wholly composed of calcareous ingredients; at other times, these constitute but about one-half, or little more than one-half of its substance, the remainder being made up of animal matter. Nor is its color more uniform. Sometimes it is black, at other times it is of a dark, pale, or yellowish brown, and in some instances it is nearly white. It also differs in density. In the mouths of some it has a solidity of texture nearly equal to that of the teeth themselves, in others, it is so soft that it can be scraped from the teeth with the thumb or finger nail. The black kind is the hardest, the white the softest, and its density is increased or diminished as it approaches the one or the other of these colors.

Salivary calculus collects in very small quantities on the teeth of persons possessed of the most perfect constitution, and, even on these it is seldom found, except on the inner surfaces of the lower incisors next the gums. It is then black, or of a dark brown ; very dry, and almost as hard as the teeth, to which it adheres with great tenacity.

It rarely happens that any unpleasant effects are produced by the presence of this kind of tartar upon the teeth. The general health is never affected by it, and the only local injury that results from it, is slight turgidity of the edge of the gums in immediate contact with it.

The indications, therefore, of this description of tartar, are favorable, both with regard to the teeth, gums and organism generally. The teeth upon which it is found are of an excellent quality and rarely affected by caries. They have the characteristics represented as belonging to the best kind, and teeth of this description are only found among persons having good innate constitutions.

There is another kind of black tartar, differing from this in many particulars. It is found in the mouths of those having good constitutions, but whose physical powers have been enervated by privation or disease, or intemperance and debauchery, and most frequently by the last named. It is found in large quantities on the teeth opposite the mouths of the salivary ducts; it is exceedingly hard, and agglutinated so firmly to the organs, that it is removed with great difficulty ; it is very black ; has a rough and uneven surface, and is covered with a glairy, viscid, and almost insufferably offensive mucus.

The presence of this kind of salivary calculus is attended with very hurtful consequences, not only to the gums, alveolar processes and teeth, but also to the general health. It causes the gums to inflame, swell, suppurate and recede from the teeth, the alveoli to waste, and the teeth to loosen and frequently to drop out. The secretions of the mouth are also vitiated by it, and rendered unfit to be taken into the stomach. Hence, as long as it is permitted to remain on the teeth, neither the skill of the physician, nor the best regulated regimen, though they may afford partial and temporary relief, will fully restore to the system its healthy functions.

As this kind of tartar is seldom if ever met with except in constitutions naturally excellent, the teeth on which it is deposited are generally sound, but they are often caused by the disease which is produced in the gums and alveoli, to loosen and drop out.

The dark brown tartar is not so hard as either of the descriptions of black. It sometimes collects in tolerably large quantities on the lower front teeth, and on the first and second superior molars; it is also often found on all the teeth, though not in as great abundance as on these. It does not adhere with as much tenacity as either of the preceding kinds, and can be more easily detached from them. It exhales a more fetid odor than the first variety, but is less offensive than the second.

The persons most subject to this kind of tartar, are of mixed temperaments—the sanguineous, however, almost always predominating. They may be denominated sanguineo-serous and bilious. Their physical organization, though not the strongest and most perfect, may, nevertheless, be considered very good. But, being more susceptible to morbid impressions, their general health is less uniform, and more liable to impairment than those possessed of the most perfect constitutions.

The effects arising from accumulations of this description of salivary calculus, both local and constitutional, are less hurtful than the variety last noticed; but like that, it causes the gums to inflame, swell, suppurate, and to retire from and expose the necks of the teeth, the alveoli to waste, the teeth to loosen and sometimes to drop out. It also gives rise to a vitiated condition of the fluids of the mouth.

Salivary calculus of a light or pale yellowish brown color, is

of a much softer consistence than the darker varieties, and is seldom found upon the teeth, except of persons of bilious temperament, or those in whom this predominates. It has a rough and, for the most part, a dry surface; it is found in large quantities opposite the mouths of the salivary ducts, and sometimes every tooth in the mouth is completely imbedded in it. It contains less of the earthy salts and more of the animal matter than any of the foregoing descriptions, and from the quantity of vitiated mucus in and adhering to it, has an exceedingly offensive smell. It is, sometimes, though not always, so soft that it may be crumbled between the thumb and finger.

Inflammation, turgescence and suppuration of the gums, inflammation of the alveolo-dental periosteum, the destruction of the sockets and loss of the teeth, and an altered condition of the fluids of the mouth, are among the local effects produced by the long continued presence of large collections of this variety of tartar. The constitutional effects are not much less pernicious. Indigestion and general derangement of all the assimilative functions are among the most common. When the deposit is not large, inflammation and sponginess of such parts of the gums as are in immediate contact with it, and fetid breath, are the principal of the unpleasant effects produced by it.

White tartar rarely collects in very large quantities, and though most abundant on the outer surfaces of the first and second superior molars, and the inner surfaces of the lower incisors, it is nevertheless frequently found on all the teeth. Its calcareous ingredients are less abundant than those of any of the preceding descriptions. Fibrin, animal fat, and mucus, constitute by far the larger portion of its substance. It is very soft, seldom exceeding in consistence common cheese curd, to which in appearance it bears considerable resemblance. Although it exerts but little mechanical irritation upon the gums, it keeps up a constant morbid action in them. Its effects, however, upon the teeth, are far more deleterious than any other description of tartar. It corrodes the enamel, and causes rapid decay of the organs. The fluids of the mouth are also vitiated by it.

It is only upon the teeth of persons of mucous habit, or those who have suffered from diseases of the mucous membranes, or

those in whom these tissues have been more or less involved, that this kind of tartar accumulates.

There is one other kind of tartar described by dental writers. It is of a dark green color, and is seen more frequently on the anterior surfaces of the upper teeth occupying the front part of the mouth, than on any of the others. It resembles more closely a stain on the enamel than salivary calculus. Children and young persons are more subject to it than adults, though it is occasionally observed on the teeth of the latter. It is exceedingly acrid, and has the effect of decomposing the enamel; the margins of the gums around the teeth having it on them are inflamed, and the sanguineous capillaries of their whole substance appear to be distended and more than ordinarily languid.

This kind of discoloration of the enamel is indicative of an irritable condition of the mucous membranes and viscidity of the fluids of the mouth. Sour eructations, vomitings, diarrhœa and dysentery are not unfrequent with those whose teeth are thus affected.

For the chemical constituents of salivary calculus, the reader is referred to a subsequent chapter, where, also, the morbid effects produced by its several varieties are treated of more at length.

CHAPTER FIFTH.

PHYSICAL CHARACTERISTICS OF THE FLUIDS OF THE MOUTH.

In treating upon the physical characteristics of the fluids of the mouth, it will not be necessary to dwell at much length on their effects, when in a morbid condition, on this cavity. Concerning their agency in the production of caries of the teeth, we shall add one or two remarks.

Saliva, in healthy persons having good constitutions, has a light frothy appearance, and but little viscidity. Inflammation of the gums, from whatever cause produced, increases its viscidity, and causes it to be less frothy. In a healthy state, it is inodorous, floats upon and mixes readily with water, but when in a viscid or diseased condition, it sinks and mixes with it with difficulty.

Irritation in the mouth, from diseased gums, aphthous ulcers, inflammation of the mucous membrane, the introduction of mercury into the system, or taking any thing pungent into the mouth, increases the flow of this fluid, and causes it to be more viscid than it is in its natural and healthy state.

In treating on the symptomatology of saliva, Prof. Schill says, "The sympathetic affection of the stomach in pregnancy is sometimes accompanied by salivation, which, in this case, mostly takes place after conception, and somtimes continues to the time of delivery. It is also observed to occur in weakened digestion, in gastric catarrhs, after the use of emetics, in mania, in what are called abdominal obstructions, in hypochondriasis and hysteria: salivation occurs during the use of mercury or antimony.

"In confluent small-pox, salivation is a favorable sign. If it cease before the ninth day the prognosis is bad. In lingering intermittents, salivation is sometimes critical; more frequently in these affections it precedes the termination in dropsy.

"Diminution of the salivary secretion, and, in consequence of

this, dryness of the mouth, is peculiar to the commencement of acute disease, as also to the hectic fevers occasioned by affections of the abdominal organs. If the flow of the saliva stop suddenly, there is reason to apprehend an affection of the brain.

"Thick viscid saliva occurs under the same circumstances as the diminution of the salivary secretion, especially in small-pox, typhus, and in hectic fevers. It is thin in ptyalism. In gastric diseases, where the liver participates, it becomes yellow or green; by the admixture of blood it may assume a reddish color; in pregnant or lying-in women, it is sometimes milky; an icy cold saliva was observed by the author in face-ache.

"Frothy saliva from the mouth is observed in apoplexy, epilepsy, hydrophobia, and in hysterical paroxysms."*

Dr. Bell, of Philadelphia, in a note to the work from which we have just quoted, says, "Acid saliva is regarded by M. Donné, as indicative of gastritis or deranged digestion. Mr. Laycock," he observes, "on the other hand, infers from numerous experiments on hospital patients, that the saliva may be acid, alkaline, or neutral, when the gastric phenomena are the same. In general, Mr. L. remarked, that it was alkaline in the morning and acid in the evening."

We have had occasion to observe, that the acid quality of the saliva was more apparent and more common in lymphatic, mucous and bilious dispositions, than in sanguineous or in sanguineo-serous persons, and that weakened or impaired digestion always had a tendency to increase it.

M. Delabarre says, "When this fluid" (the saliva) "has remained in the mouth some moments, it there obtains new properties, according to each individual's constitution and the integrity of the mucous membrane, or some of the parts which it covers.

"In subjects who enjoy the best health, whose stomach and lungs are unimpaired, the saliva appears very scarce, but this is because it passes into the stomach almost as soon as it is furnished by the glands that secrete it. It only remains long enough in the mouth to mix with a small quantity of mucus, and absorb a certain portion of atmospheric air, to render it frothy.

"On the other hand, the saliva of an individual whose mucous

* *Outlines of Pathological Semeiology;* edition of the Select Medical Library, pp. 173–4.

system furnishes a large quantity of mucus, is stringy and heavy; is but slightly charged with oxygen, contains a great proportion of azote and sulphur, and stains silver."*

Increased redness and irritability of the mucous membrane of the mouth, is an almost invariable accompaniment of general acidity of these fluids. Excoriation and aphthous ulcers, and bleeding of the gums, also, frequently result from this condition of the salivary and mucous secretions of this cavity.

Anorexia, languor, general depression of spirits, head-ache, diarrhœa, and rapid decay of the teeth, are very common among persons habitually subject to great viscidity of the buccal fluids. It is likewise among subjects of this kind, and particularly when the viscidity is so great as to cause clamminess of these secretions, that the green discoloration of the enamel of the teeth is most frequently met with.

* Vide *Traité de la Seconde Dentition.*

CHAPTER SIXTH.

PHYSICAL CHARACTERISTICS OF THE LIPS.

The indications of the physical characteristics of the lips are more general than local, and the observations of Laforgue and Delabarre on this subject, leave little to be added. We cannot, therefore, do much more than repeat what they have said.

"The lips," says Delabarre, "present marked differences in different constitutions. They are thick, red, rosy or pale, according to the qualities of the blood that circulates through their arteries."

Firmness of the lips, and a pale rose color of the mucous membrane that covers them, are, according to Laforgue, indicative of pure blood, and, as a consequence, of a good constitution. Redness of the lips, deeper than that of the pale rose, is also mentioned as one of the signs of sanguineo-serous blood. Soft, pale lips are indicative of lymphatico-serous dispositions. In these subjects the lips are almost entirely without color. When there is a sufficiency of blood the lips are firm, though variable in color, according to the predominancy of the red or serous parts of this fluid.

Both hardness and redness of the lips, and all the soft parts of the mouth, are enumerated among the signs of plethora. Softness of the lips, without change of color in their mucous membrane, is spoken of by the last author as indicative of deficiency of blood; and softness and redness of the mucous membrane of the lips are signs that the blood is small in quantity and sanguineo-serous.

Deficiency in the red corpuscles, and in the nutritive qualities of the blood, is evidenced by the want of color and softness of the lips, and general paleness of the mucous membrane of the whole mouth. "The fluids contained in the vessels," says Laforgue, "in forms of anæmia, yield to the slightest pres-

sure, and leave nothing between the fingers but the skin and cellular tissue."

In remarking upon the signs of the different qualities of the blood, the above mentioned author asserts that the constitution of children, about six years of age, cannot be distinguished by any universal characteristic; but that the lips, as well as the other parts of the mouth, constantly betoken "the quality of blood and that of the flesh;" and, "consequently, they proclaim health or disease, or the approach of asthenic and adynamic disorders, which the blood either causes or aggravates."

Again, he observes, that the blood of all children is "superabundantly serous," but that it is redder in those of the second constitution than in those of any of the others; and that this is more distinctly indicated by the color of the lips. "This quality of the blood," says he, "is necessary to dispose all the parts to elongate in their growth. When the proportions of the constituent elements of the blood are just, growth is accomplished without disease. If the proportions are otherwise than they should be for the preservation of the health, or if one or more of its elements be altered, health no longer exists, growth is arrested altogether, or is performed irregularly. The nutritive matter is imperfect—assimilation is prevented or impaired. On the other hand, its disintegration decomposes the patient; if death does not sooner result, it will consume him by the lesion of some vital organ."*

The changes produced in the color of the blood by organic derangement are at once indicated by the color of the lips.

The accuracy of Laforgue's observations on the indications of the physical characteristics of the lips, has been fully confirmed by subsequent writers. Delabarre, in his remarks on the semeiology of the mouth, has added nothing to them.

"The secretion of the lips," says Professor Schill, "has a similar diagnostic and prognostic import to that of the tongue and gums. They become dry in all fevers and in spasmodic paroxysms. A mucous white coating is a sign of irritation or inflammation of the intestinal canal; accordingly, this coating is found in mucous obstructions, in gastric and intermittent

* Vide *Semeiologie Buccale et Buccamancie.*

fevers, in mucous fever, and before a gouty paroxysm. A dry brown coating of the lips is a sign of colliquation in consequence of typhus affections; it is accordingly observed in typhus, in putrid fever, in acute exanthemata, and inflammations which have become nervous."*

The lips, however, do not present so great a variety of appearances as those of other parts of the mouth, for the reason that they are not as subject to local diseases; but their general pathological indications are, perhaps, quite as decided.

* Vide *Pathological Semeiology,* p. 152.

CHAPTER SEVENTH.

PHYSICAL CHARACTERISTICS OF THE TONGUE.

The appearance of the tongue, both in health and disease, is regarded by physicians as furnishing more correct indications of the state of the constitution and general health than any of the other parts of the mouth. It is asserted, however, by others, and by those, too, who have the very best opportunities for inspecting the various parts of this cavity, that the lips and gums furnish as marked and reliable indications as the tongue. That the state and quality of the blood can be as readily ascertained by an examination of these parts, as by that of the tongue, is, we believe, undeniable; but that the pathological condition of the body can be inferred is a question we leave for others to decide.

So far as the quality of the blood and the temperament of the subject are indicated by the color of the tongue, the preceding remarks concerning the lips will be found applicable. The one being as much influenced by them as the other. It will, therefore, be unnecessary to recapitulate what we have before said upon the subject.

The effects produced upon the mucous membrane of the tongue by disease in any other part, are said to be analogous to those produced on the general integument. So, also, are the changes of its color, consistence, humidity and temperature similar to those of the skin. We are likewise told that the changes of its coating agree with the analogous changes of the perspiration, and that these phenomena are more decided in acute than in chronic affections.*

But the diagnostic and prognostic indications of the tongue vary according to the temperament and constitutional predisposition of the individual. The physician should acquaint himself with its appearances in health, to be able to determine correctly its indications in disease. He should likewise inform himself of

* Vide *Professor Schill's Semeiology.*

the changes produced in its appearance by certain morbid conditions of the body. In some subjects it is always slightly furred and rather dry, especially near its root; in others it is always clean and humid; in some, again, it is always red, and in others pale.

Professor Schill divides the signs of the tongue into objective and subjective. "To the objective belong the changes of size, form, consistence, color, temperature, secretion, and of power and direction of motion; and to the subjective belong the anomalous sensations of taste."

In enumerating the pathognomonic signs of the tongue, this author says that hypertrophy, inflammation or congestion, may occasion its enlargement; and that inflammatory swelling of it, when arising from acute diseases, such as "angina, pulmonary inflammation, measles, plague, or variola, yields an unfavorable prognosis. Even non-inflammatory swelling of the tongue is a dangerous phenomenon in acute diseases, especially cerebral, which are combined with coma. If it be the consequence of mercury, of the abuse of spirtuous drinks, of gastric inflammation, of chlorosis, of syphilis, or if it occur in hysteria or epilepsy, the prognosis is not dangerous; but the disease is always the more tedious where the tongue swells than where it does not. It is enlarged, also, by degenerescence and cancer."

"Diminution of the size of the tongue takes place where there is considerable emaciation. In this case it continues soft and movable. If, in acute states, the tongue becomes small, and is, at the same time, hard, retracted and pointed, the irritation is very great, and the prognosis bad. This sign occurs more especially in typhus, in the oriental cholera, in inflammation of the lungs, and in acute cerebral affections. In hysteria and epilepsy this phenomenon has no unfavorable import."

Internal maladies, he says, seldom cause the form of the tongue to change; but that the simplest change arising from chronic irritations of the stomach, chronic dyspepsia, and acute exanthemata, is enlargement of its papillæ. In cases of protracted dyspepsia, the edges of the tongue sometimes crack, and in paralysis and epilepsy, it becomes elongated.

In acute diseases, a soft tongue is a favorable indication; and flaccidity of it is symptomatic of debility.

Humidity of the tongue, he tells us, is a favorable sign, and that dryness of it occurs in acute or violent inflammations and irritations, and more particularly when seated in the intestinal canal and respiratory organs. "This also happens in diarrhœa, typhus, pneumonia, gangrene of the lung, pleuritis, peritonitis, enteritis, catarrhus gastricus, gastritis, inflammation of joints, etc. Among the higher degrees of dryness, he enumerates the rough, the fissured and burnt tongue, as furnishing still more unfavorable indications; informing us, at the same time, that if these be not accompanied by thirst, they prognosticate a fatal termination. The abatement and crisis of the disease is indicated by the tongue becoming moist."

Dr. Bell, of Philadelphia, in a note to Professor Schill's observations on the tongue, says, "A rough and dry, and even furred tongue, is seen in some dyspeptic persons, who sleep with the mouth open; and although it indicates an irritation of the digestive organs, it is not a bad augury." Bilious persons, not unfrequently, though not troubled with any manifest symptoms of gastric or intestinal derangement, or any other apparent functional disturbance, have a furred tongue in the morning.

Paleness of the tongue, says Professor Schill, is a sign of a serous condition of the blood, of chlorosis, of great loss of blood, of chronic disorders, of sinking of the strength in acute maladies, assuming a "nervous form, as typhus and scarlatina maligna. It is also found," says he, "in enteritis and dysentery, when but little fever is present." He infers from this, that paleness of the tongue is caused by the "drawing of the fluids downward;" but it is often observed in persons who enjoy tolerably good health. Lymphatic dispositions, as has been before remarked, are peculiarly subject to it.

Again, he observes, that a very red tongue is indicative of "violent inflammation, mostly of the intestinal canal, but also of the lungs and pharynx; also of acute exanthemata." He regards the prognosis as bad, when a furred tongue "in acute diseases of the intestinal canal becomes clean and very red," if the change is not accompanied with the return of the patient's strength. "But," he continues, "if the debility is not considerable, and the tongue becomes clean aud very red, whilst other febrile symptoms continue, a new inflammation may be expected." But

even in affections like these, the redness of the tongue is always more considerable in sanguineous, than in lymphatic or lymphatico-serous subjects, so that in forming a prognosis from this sign, the temperament of the individual should never be overlooked.

Proceeding with the description of the signs of this organ, he says, "The tongue becomes a blackish-red and bluish-red in all serious disturbances of the circulation and respiration, as also in severe diseases of the lungs and heart, as catarrhs, suffocations, asthma, extensive inflammations of the lungs, carditis, Asiatic cholera, plague, confluent small-pox, and putrid fevers. It becomes black and livid in cases of vitiation of the blood, more especially in scurvy, at the setting in of gangrene, and in phthisis, when death is near at hand."

Among the diseases mentioned as giving rise to an increase of the temperature of the tongue, are glossitis, violent internal inflammation and typhus fever; and coldness of this organ is observed to take place in Asiatic cholera, and at the approach of death.

The signs from the secretion of the tongue are thus enumerated: A clean and moist tongue are favorable indications, but a clean, dry and red tongue, as seen in slow nervous fevers, acute exanthemata and plague, are bad auguries. A furred or coated tongue is said to occur chiefly in intestinal disorders, diseases of the lungs, skin, and in rheumatic affections. The coating is said to vary in "color, thickness, adherence, and extent," and different kinds of secretion from the mucous membrane of this organ are mentioned as occurring in different diseases, and it should have been added in the same disease in different temperaments.

After describing the various kinds of coating on the tongue, together with their respective indications, which it is not necessary here to enumerate, the occurrence of false membranes and pustules, resulting from peculiar forms of mucous secretion, are next mentioned. The former show themselves either as small white points, or large patches, and sometimes they are said to envelop the whole tongue. The color is "sometimes white, sometimes yellow and sometimes red," and the greater the surface covered by them, the more unfavorable is the prognosis regarded. "Pustules on the tongue," says our author, "are sometimes idiopathic, but in most cases symptomatic. They are either

distinct or confluent; the confluent are the worst. Those which are hardish and dry, and also those which are blue, and those of a blackish appearance, which sometimes occur in acute diseases, are of an unfavorable import." On the other hand, those which have a whitish, soft, moist, and semi-transparent appearance, are less unfavorable, and when the aphthæ, or eruption, are repeated, it portends a longer continuance of the malady. The pustules or aphthæ are mentioned as being frequent accompaniments to the following diseases: namely, gastritis, catarrhs, enteritis, metritis, dysentery, cholera infantum, peritonitis, intermittent and typhus fevers, pleuritis, pneumonia, and the third stage of pulmonary consumption. Their prognosis is said to be favorable, when "they appear with critical discharges after the seventh day," and unfavorable, when they occur as a consequence of a general sinking of the physical powers of the body.*

But it is unnecessary to enumerate all of the pathognomic indications of the various morbid phenomena described by semeiologists; we have noticed more of them than was our intention to have done. We shall, therefore, conclude the present inquiry, by simply observing, that the indications furnished by the physical characteristics, not only of the tongue, but by those, also, of the teeth, the gums, salivary calculus, the lips and fluids of the mouth, are, as we have endeavored to show, essential to the successful exercise of the duties both of the dental and medical practitioner.

* Vide *Professor Schill's Semeiology.*

PART THIRD.

DISEASES OF THE TEETH AND THEIR TREATMENT.

DISLOCATION OF THE LOWER JAW.

PART THIRD.

DISEASES OF THE TEETH.

The doctrine, as promulgated by Fox, and, subsequently, advocated by Bell, and other European writers, that the diseases of the teeth are the same as those which attack other osseous structures of the body, is now almost universally conceded to be incorrect. With the exception of exostosis and necrosis, the pathological conditions of these organs do not bear the slightest analogy to those of other bones. They are not produced by the same causes, nor can they be cured by the same remedies.

In the treatment of diseases of the teeth we rely mainly upon art; in diseases of other osseous tissues the resources principally to be relied on are found in the recuperative powers of the economy. This difference is clearly seen between caries in the teeth and in the bones. Nature alone can repair the ravages of the one, art alone of the other. Exostosis, which is a disease common to bone and teeth, is found only in the cementum, which is the connecting link between dentine and osseous tissue; whilst diseases of the dentine and enamel form a distinct class, requiring treatment altogether peculiar to themselves.

The teeth are more liable to be attacked by caries than by any other disease, and this, therefore, will first claim our attention.

CHAPTER FIRST.

CARIES OF THE TEETH.

Caries of a tooth is the chemical decomposition of the earthy salts of the affected part, sometimes, but not always, accompanied by disorganization of the animal frame work of this portion of the organ. There is no affection to which these organs are liable more frequent in its occurrence, or fatal in its tendency, than this. It is often so insidious in its attacks, and rapid in its progress, that every tooth in the mouth is involved in irreparable ruin, before even its existence is suspected.

Its presence is usually first indicated by an opaque or dark spot on the enamel; and, if this be removed, the subjacent dentine will exhibit a black, dark-brown or whitish appearance. It usually commences on the outer surface of the dentine of the crown, beneath the enamel, at some point where it is imperfect or has been fractured or otherwise injured; from thence it proceeds toward the centre of the tooth, increasing in circumference, until it reaches the pulp-cavity.

If the diseased part is of a soft and humid character, the enamel, after a time, usually breaks in, disclosing the ravages the disease has made on the subjacent dentine. But this does not always happen; the form of the tooth sometimes remains nearly perfect, until its whole interior structure is destroyed.

No portion of the crown or neck of a tooth is exempt from this disease; yet, some parts are more liable to be first attacked than others; as, for example, the depressions in the grinding surfaces of the molars and bicuspids, the approximal surfaces of all the teeth, the posterior or palatine surfaces of the lateral incisors; and, in short, wherever an imperfection of the enamel exists.

The enamel is much harder than the dentine, and is by far less easily acted on by the causes that produce caries. It is sometimes, however, the first to be attacked, and when this

happens, the disease develops itself more frequently on the labial, or buccal surface near the gum, than in any other locality; often commencing at a single point, and at other times at a number of points. When the enamel is first attacked, it is usually called erosion; but as this tissue does not contain so much animal matter as the subjacent dentine, the diseased part is often washed away by the saliva of the mouth; while in the dentinal part of the tooth, it, in most instances, remains, and may be removed in distinct laminæ, after the earthy salts have been decomposed.

In very hard teeth, the decayed part is of a firmer consistence, and of a darker color, than in soft teeth. Sometimes it is black; at other times of a dark or light brown; and at other times again, it is nearly white. As a general rule, the softer the tooth, the lighter, softer and more humid the caries. The color of the decayed part, however, may be, and doubtless is, in some cases, influenced by other circumstances; perhaps by some peculiar modification of the agents concerned in the production of the disease.

The disease, then, not being the result of any vital action, the applicability of the term caries may be questioned; but, as it has been very generally sanctioned, and as we know of no better name, we shall continue its use. Mr. Bell has substituted the term gangrene, under the belief that it conveys a more correct idea of the true nature of the affection. The applicability of a term, almost synonymous with this, is also suggested by Mr. Hunter: in speaking of the affection, he says, that it "appears to deserve the name of mortification." Mr. Fox speaks of the decay of the teeth, as a disorder which terminates in mortification; but he designates it by the name of caries. We prefer this term, inasmuch as that of gangrene or mortification may be applied to another condition of the teeth—necrosis, with as much propriety as to the one now under consideration. Moreover, the term gangrene, or mortification, is commonly used to signify the death of a soft part, and not a diseased condition of bony tissue. Surgical writers usually regard gangrene in soft tissues as analogous to necrosis in osseous tissues; and ulceration in the first analogous to caries in the last. But necrosis and caries in the teeth differ in causes, symptoms, sequelæ and treatment, from

affections of the same name in other bones, in consequence of the great difference in their structure, function and mode of connection with the adjacent tissues.

Commencing externally beneath the enamel, the disease proceeds, as before stated, towards the centre of the tooth, destroying layer after layer, until it reaches the lining membrane, leaving each outer stratum softer, and of a darker color than the subjacent one.

The terms, *deep seated*, *superficial*, *external* and *internal*, *simple* and *complicated*, have been applied to the disease. These distinctions are unnecessary, since they only designate different stages of the same affection. By complicated decay, is meant caries which has penetrated to the pulp-cavity of the tooth, accompanied by inflammation and suppuration of the lining membrane, and the death of the organ. The lining membrane, however, is not always inflamed by exposure, nor is inflammation invariably followed by suppuration.

Equally unnecessary is the classification adopted by M. Duval, to designate differences of color and consistence in the decayed part. He enumerates seven varieties or species, as follows: *calcareous*, *peeling*, *perforating*, *black*, *deruptive*, *stationary*, and *wasting*.

The *first*, he employs to denote an affection of the teeth characterized by the appearance of a white opaque spot on the enamel, whereby it is rendered brittle, and which often causes it to break. The *second*, if not identical with, is at least analogous to, the first, except in the different color of the enamel. The *third* is caused by a defect in almost every part of the enamel covering the crowns of the teeth; it attacks the molars and sometimes the bicuspids, at a number of points simultaneously, causing speedy destruction. The *fourth*, he describes as not occurring until from the fifteenth to the thirtieth year, and as being principally confined to persons of consumptive habit, and those disposed to rachitis. The color of the decayed part of a tooth in individuals having such morbid proclivity, is sometimes black, but more frequently white. Black caries, as it is called, is oftener met with in the teeth of persons of good constitution, and in hard rather than soft teeth.

The *fifth species*, or deruptive, he represents as that which,

in persons of consumptive habit, attacks the front teeth near their necks, extending downward toward their roots, and forming a brownish semicircular groove. The *sixth* is that description, which, after having penetrated a certain distance into the substance of the tooth, becomes stationary. The *seventh*, and last species, is characterized by the gradual wasting of the grinding surfaces of the molars, dipping down in some places to a considerable depth, and leaving a smooth polished surface of a brown or yellowish color.

Finally, the roots of the teeth frequently remain firm in their sockets for years after the crowns and necks have been destroyed, showing that they are less liable to decay than the crowns; but nature, after the destruction of the last, as if conscious that the former are of no further use, exerts herself to expel them from the system, which is effected by the gradual wasting and filling up of their sockets. After this operation of the economy has been accomplished, they are frequently retained in the mouth for months, and even for years, by their periosteal connection with the gums. This effort of nature is confined more to the back than to the front teeth; it often happens that the last remain, after the destruction of their crowns, for many years, and sometimes without much apparent injury to the parts within which they are contained.

DIFFERENCES IN THE LIABILITY OF DIFFERENT TEETH TO DECAY.

Having explained at some length, in a preceding part of this work, the manner in which the physical condition of the teeth is influenced, it will not now be necessary to dwell upon this portion of the subject. It will only be requisite to state, therefore, that teeth which are well formed, well arranged, and of a firm texture, seldom decay, and when they are attacked, the progress of the disease is not rapid; whereas, those that are imperfect in their formation, and of a soft texture, are more susceptible to the action of the causes which produce it; and when assailed, if the progress of the affection is not arrested by art, they usually fall speedy victims to its ravages. Just in proportion as the dentinal structure of the teeth is hard or soft, the shape of the organs

perfect or imperfect, their arrangement regular or irregular, is their liability to caries diminished or increased.

The density, shape and arrangement of the teeth are influenced by the state of the general health, and that of the mouth, at the time of their dentinification. If, at this period, all the functions of the body are healthily performed, these organs will be compact in their structure, perfect in their shape, and usually regular in their arrangement. That the teeth should be thus influenced will not appear strange, when we consider, as Richerand remarks, "that there exists amongst all the parts of the living body intimate relations, all of which correspond to each other, and carry on a reciprocal intercourse of sensations and affections. Hence, if there is a morbid action in one part, other parts sympathize with it, rallying, as if sensible of the mutual dependence existing between them, all their energies to rescue their neighbor from the power of disease."

Increased action in one portion of the system, is generally followed by diminished action in some other part; thus for example, gastritis may be produced by constipation of the bowels: puerperal fever, by diminished action in the heart with an increased action in the uterus: etc. Hence, we may conclude, that if the body, at an early age, be morbidly excited, its functions will be languidly performed—the process of assimilation checked—the regular and healthy supply of earthy matter in the bones interrupted—and, consequently, that the teeth which are then formed will be defective. Other parts of the body, in which constant changes are going on, if thus affected at these early periods, may afterwards recover their healthful vigor; but if the teeth are badly formed, they must ever, because of their low degree of vascularity, continue so; hence they will be more liable to decay than when dentinified under other and more favorable circumstances.

Capillary blood-vessels form a large part of every organ, the characteristic tissue of each being strictly *extra-vascular* (literally, *outside of the vessels*). Where the blood-vessels are most abundant, as in the nervous and muscular structures, growth and change take place rapidly and constantly; since almost every particle of the extra-vascular or interstitial tissue is in contact with the circulating fluid, the function of which is to supply ma-

terial for growth and carry off waste matter. Hence such organs have great recuperative power, and are modified by the varying conditions of the body. But the dentine and enamel of the teeth are vascular only during the period of development. These structures, once formed, pass beyond the reach of the capillaries, except the layer of dentine in contact with the dental pulp. Hence, the dental pulp may deposit new bone as a barrier against caries; but the carious dentine itself is incapable of self-restoration.

"That the teeth acquire this disposition," says Mr. Fox, "to decay, from some want of healthy action during their formation, seems to be proved by the common observation, that they become decayed in pairs; that is, those which are formed at the same time, being in a similar state of imperfection, have not the power to resist the causes of the disease, and therefore, at nearly about the same period of time exhibit signs of decay; while those which have been formed at another time, when a more healthy action has existed, have remained perfectly sound to the end of life."

Most writers are of opinion, that the power of the teeth to resist the various causes of decay is sometimes weakened by a change brought about in their physical condition through the agency of certain remote causes, such as, the profuse administration of mercury, the existence of fevers, and all severe constitutional disorders.

Mr. Fox says: "That he has had occasion to observe, that great changes take place in the economy of the teeth in consequence of continued fever; and that the decay of the teeth is often the consequence of certain states of the constitution."

Mr. Bell remarks: "That amongst the remote causes, (of decay,) are those which produce a deleterious change in the constitution of the teeth, subsequent to their formation; one of the most extensive, in its effects, is the use of mercury. To the profuse administration of this remedy in tropical diseases we may, we think, in a great measure, attribute the injury which a residence in hot climates so frequently inflicts on the teeth."

Severe constitutional disorders, and the administration of certain kinds of medicine, do not, as Messrs. Fox and Bell suppose, act directly on the teeth, by altering their physical condition

and thus rendering them more susceptible to the action of corrosive agents; but they are indirectly affected in proportion as the secretions of the mouth are vitiated and their corrosive properties increased.

The following considerations establish, to our mind, the truth of what we have just stated. Artificial teeth of bone or ivory, which can undergo no such changes as those mentioned by Mr. Bell, decay more rapidly after the profuse administration of any medicine, or during the existence of any disease that tends to vitiate the secretions of the mouth, than at other times. Furthermore, teeth of so dense a texture, as to be capable of resisting the action of the acidulated buccal fluids are not affected by constitutional disease; yet they are just as liable as those of a spongy texture, to any structural disease communicated from the general system.

The following is the result of our own observations: The gums and alveolar processes are sometimes destroyed by the use of mercury, so that all the teeth loosen and drop out, without being affected by caries. The teeth of persons, in whom a mercurial diathesis has been for a long time kept up, or who have been for years suffering from dyspepsia, phthisis, fevers, or other severe constitutional disorders, often continue perfectly sound; while other teeth, under similar circumstances, frequently decay. Now, all this goes to prove, not that changes are effected in the structural condition of the teeth, whereby their predisposition to decay is increased; but that there are differences in the capabilities of different teeth to resist the action of the secretions of the mouth, made acrid by the affections just enumerated.

The author is well aware that he differs from some writers on this point, as well as from received popular opinion. The views which he has here presented, are not the result of mere closet reflections, but of long and attentive observation. He has noted the effects of mercury, and of other medicines, as well as of constitutional diseases of the severest and most protracted kinds, and he has always observed, that—occurring *after* the development of the teeth—it was only as they impaired the healthy qualities of the fluids of the mouth, that they affected these organs. In fact, their density, their exposed situation, their functions, all would seem to indicate, that such changes as

take place in other parts of the body, are not only unnecessary, but many of them are impossible, and designedly so, that they may more fully answer their purpose.

Dr. Good says: "That caries of the teeth does not appear to be a disease of any particular age or temperament, or state of health." It is true it is not a disease of any particular state of health, farther than that certain constitutional affections exert a deleterious influence upon the secretions of the mouth, and thus become indirect causes of decay of these organs. That it is not a disease of any particular age, seems to contradict common experience, for it *comparatively* seldom happens that caries appears after the age of forty. The reason of which is obvious. Teeth of a loose texture, or otherwise imperfect, cannot resist the action of the causes of decay, to which all teeth are, up to this period of life, more or less exposed; while those which from their greater density remain unaffected thus long, are generally enabled, by the increased solidity they gradually acquire, to resist them through life. Teeth sometimes, though rarely, decay at fifty, or even at a later period; but caries of the teeth, generally, may be said to be confined to youth and middle age.

The formation, arrangement and physical condition of the teeth are sometimes influenced by hereditary diathesis, affecting the parts concerned in their production, or the general system. That a morbid condition of the system, on the part of either parent, often predisposes their progeny to like affections, is an axiom fully recognized in pathology, and a fact of which we have many fearful proofs.

Mr. Bell, in treating of what he calls the hereditary predisposition of the teeth to decay, remarks: "That it often happens that this tendency exists in either the whole or a great part of a family of children, where one of the parents had been similarly affected; and this is true to so great an extent, that we have commonly seen the same tooth, and even the same part of a tooth, affected in several individuals of the family, and at about the same age. In other instances, where there are many children, amongst whom there exists a distinct division into two portions, some resembling the father, and some the mother, in features and constitution, we observe corresponding differences in the teeth, both as it regards their form and texture, and their tendency to decay."

That there is an hereditary tendency in the teeth to decay, cannot, we think, be denied. But we believe it to be the result of the transmission of a similarity of action in the parts concerned in the production of these organs; so that the teeth of the child are, in form and structure, like those of the parent whom it most resembles, and from whom it has inherited the diathesis. The teeth of the child, if shaped like those of the parent, possessing a like degree of density, and similarly arranged, are equally liable to disease; when exposed to the action of the same causes they are affected in like manner, and, usually, at about the same period of life. Such being the fact, is it unreasonable to conclude, that judicious early attention may so influence the formation and arrangement of the teeth, that their liability to disease may be diminished? Whilst denying the direct action of medicine and sickness upon the dental tissues, except through the agency of the buccal secretions, we admit their powerful influence; first, through hereditary transmission of an impaired constitution; secondly, by their action upon the process of development, if given while the teeth are being formed. It is, then, to the differences in the physical condition and manner of arrangement of these organs,—whether in different individuals or in the same mouth,—that the differences in their liability to decay is attributable.

CAUSES OF CARIES.

Caries of the teeth has been attributed to a great variety of causes. To notice, in detail, the various opinions advanced by American, English, French and German writers upon this subject, would be inconsistent with the plan of an elementary treatise like this, and unprofitable to the reader; we shall, therefore, give simply a brief exposition of the views of a few of the most prominent writers. If, in doing this, we shall have occasion to differ from any, we trust we shall be able to give satisfactory reasons for so doing.

Fauchard, Auzebè, Bourdet, Lecluse, Jourdain, and most of the French writers of the eighteenth century on the diseases of the teeth, as well as nearly all of the more modern French authors, though their views with regard to the causes of dental

caries are exceedingly vague and confused, express the belief that the disease is, for the most part, the result of the action of chemical agents; such, for example, as vitiated saliva, the putrescent remains of particles of food lodged between the teeth, or in their interstices, acids, and a corrupted state of the fluids conveyed to these organs for their nourishment. They also mention certain states of the general health, mechanical injuries, sudden transitions of temperature, etc., as conducing to the disease. A similar explanation, too, of the cause is given by Salmon, the author of a Compendium of Surgery, published in London, in 1644. The foregoing is a general summary of the views entertained by most of the older writers with regard to the causes of this disease. If they are not strictly correct, we think we shall presently be able to show that they are not altogether erroneous.

In the English school of dental surgery, since the time of the publication of Mr. Fox's celebrated treatise on the Natural History and Diseases of the Teeth, and until quite recently, inflammation of the dentine has been regarded as the proximate or immediate cause of the disease. Having discovered an identity of structure between the teeth and the bones of the body, this author immediately concluded that the diseases of the one were identical with those of the other. This inference, it must be confessed, to one who has not made the diseases of the former a subject of close and critical investigation, would seem to be irresistible. But it is none the less incorrect, so far, at least, as most of the diseases of the teeth are concerned. By instituting a comparison between caries of the teeth and that of bone, it will at once be perceived that there is not the slightest analogy between the disease, as it occurs in the one, and as it shows itself in the other. In the former, it consists simply in a decomposition of the earthy salts of the organs, whereas, in the latter, it is analogous to ulceration in soft parts, constantly discharges purulent matter, and often throws out fungous granulations. These phenomena, which dental caries never presents, establish a wide difference of character between it and the disease as occurring in the true osseous structures of the body.

But the promulgation of the doctrine of the vascularity of the teeth, not only led to the belief that caries of these organs was

identical with caries of bone; but it soon gave rise to the supposition, that, inasmuch as inflammation was the cause which determined it in the latter, it also produced it in the former.* Among the ablest advocates of this theory is Mr. Thomas Bell; but notwithstanding the support which it has received from his pen, it is opposed by facts which prove it, most conclusively, to be erroneous.

If inflammation of the dentinal structure of the teeth were the cause of caries, the disease would be as likely to develop itself in one part of a tooth as another. The root, the interior of the crown between the pulp-cavity and the enamel, would as frequently be the part first attacked as the external surface. Now what are the facts in relation to this matter? Does caries ever commence on the root of a tooth, or between the pulp-cavity and the periphery of the dentine? Most assuredly not.

Again, among the causes which would be most likely to excite inflammation in these organs, are many of the operations performed for arresting the progress of the disease. For example, it is well known that filing and plugging, two of the most valuable operations in dental surgery, augment, for a time at least, the sensibility of the teeth, and increase their susceptibility to the action of heat and cold—agents regarded as among the most frequent and powerful exciting causes of inflammation. Now, if dental caries were the result of inflammation, these operations, instead of arresting the progress of the disease, would cause a recurrence of it, and hasten the destruction of those teeth upon which they had been performed.

Inflammation of the lining membrane of a tooth may end in suppuration, but we cannot believe that inflammation of its dentinal structure alone, causes a decomposition of any portion of its substance, though it may influence the susceptibility of the tooth to the action of caries. For were such a change produced by any vital action, the part deprived of vitality would be exfoliated,

* The doctrine of the vascularity of the teeth, as maintained by Fox, was the origin in England of the theory, that caries of these organs resulted from inflammation of their dentinal structure; but the doctrine had been advanced at a much earlier period in France. The celebrated French surgeon, Ambrose Paré, in treating on tooth-ache, says, "These organs, after the manner of other bones, suffer inflammation, and quickly suppurate, become rotten," etc., book xvii, chap. xxv, page 387; edition, 1579.

and its loss repaired by the formation of new dentine, which never happens; hence, we are led to conclude that the vital powers of the teeth are too weak to set up an action capable of effecting the decomposition, exfoliation, or restoration of any portion of their substance. Were their living powers more active, it is probable their diseases would be more analogous to those of bone.

If inflammation of the dentine, then, is not the cause of the affection, how is the disease produced? This question can only be answered in one way. It is the result of the action of external chemical agents. This explanation of the cause is not based upon mere hypothesis, but is supported by facts that cannot be successfully controverted. It is well known, that the fluids of the mouth, especially the mucous, when in a vitiated condition, are capable of decomposing the enamel of such teeth as are not possessed of more than ordinary density. The truth of this assertion is demonstrated by the fact that dead teeth, and the crowns of human teeth, and those of animals, when employed as substitutes for the loss of the natural organs, are as liable to decay as living teeth, and the decayed part in the one, exhibits nearly the same characteristics as in the other. The same is true, too, with regard to all artificial teeth constructed from bone of any sort, or ivory. Now, if the disease was dependent upon any vital operation, neither dead teeth nor such dental substitutes as we have mentioned, would ever decay. But inasmuch as they do, is it not reasonable to suppose that the cause which produces it in the one case is capable of producing it in the other?

But it may be asked, if caries be produced by the action of external corrosive agents, how is it that the disease sometimes commences within the structure of a tooth, and makes considerable progress there, before any indications of its existence are observed externally? We answer, that it never does commence there; its attacks, as we have before remarked, are always upon the external surface; sometimes upon the enamel, but most frequently upon the dentine beneath the indentations in the grinding surfaces of the bicuspids and molars, and in the approximal sides of the teeth, where this outer covering is often so fractured by the pressure of the organs against each other, that the secre-

tions of the mouth find ready access to the subjacent dentine. Decay may be gradually going on here for months or years without any manifest signs of its existence: and the progress of the disease in these places has led many to suppose that it had its origin from within.

A thorough investigation of this subject ought to convince any one, that caries always commences externally. If it commenced in the interior or within the dentinal substance, as is asserted by some English writers, "the sphere of usefulness," as is very justly remarked by Dr. Fitch, "on the part of the surgeon dentist, would be, to say the least of it, extremely limited. For, if their observations (alluding to those of Hunter, Fox, Koecker and other European writers) are true, this disease, in its commencement, in one-half of the cases, is entirely out of the reach of medical aid." Dr. Fitch, however, believes that it does sometimes commence within the substance of the tooth.

But a still more absurd theory in regard to the cause of the disease is advanced by Mr. Charles Bew. He attributes it to the arrest of the circulation in the organs, "by the lateral pressure of the teeth against each other."

The exposure of the teeth, too, to sudden changes of temperature, as from heat to cold, or cold to heat, has been regarded almost from time immemorial as the cause of their decay; but no explanation was attempted of the manner in which these agents produce the disease, until the promulgation of the doctrine that it was the result of inflammation; they were then numbered among the *exciting causes.* The popular belief that cold is a cause of dental caries, is traced back to Hippocrates, who, in mentioning the parts of the body injuriously affected by it, includes the teeth.*

M. Ribe endeavors to prove that hot food is a cause of caries, from the fact, that "man is the only animal accustomed to hot food, and almost the only animal affected with carious teeth." Had this writer instituted a comparison between the teeth of man and of brutes, and between the solvent agents to which they are respectively exposed, he might, perhaps, have traced the decay of the human teeth to its proper cause.

* Frigidum inimicum ossibus, dentibus, nervis, cerebro, spinali medullæ; calidum vero utile. *Aph. sec. v.*—par. 18.

"The Indians of North America," says M. Tillæus, "knew nothing of the inconvenience of carious teeth and debilitated stomachs, until after the introduction of tea amongst them." From this, one might suppose that tea caused the teeth to decay, and that dyspepsia was mainly attributable to its use. The decay of the teeth of these people, since the introduction of tea amongst them, may, however, be more plausibly accounted for. The susceptibility of these organs to the action of such causes as produce the disease, have been greatly increased by the impaired state of their general constitutional health occasioned by the use of spirituous liquors, and the luxuries common to civilized life, in which they have indulged.

Particular sorts of diet, too, such for example, as animal food, are said to exercise an unhealthy influence upon the teeth. In proof of the assertion, it is stated, that Indian nations, who live principally upon vegetables, scarcely ever have a tooth to decay. But the same may be said of those nations who subsist chiefly on animal diet, and who enjoy an equal degree of constitutional health. Savage and barbarous people usually have better teeth than those of civilized nations, probably for the reason that their systems are not enervated by luxurious living. So far as diet is capable of affecting the health of the body, it may be considered as an indirect cause of caries; for the health of the child is not always dependent on the health of the parent. To the absence of disease in the general system during childhood, the period when the teeth of second dentition are being formed, the soundness of the teeth of savages may be ascribed.

It is absurd to suppose that caries of the teeth is attributable to the use of animal food. It is incapable, even in a putrid state, of exerting any hurtful action on them. The fibres of animal matter may be retained between the teeth longer than particles of vegetable substance, and by retaining the secretions of the mouth until they become vitiated, contribute indirectly to caries.

Those parts of the teeth which are covered with thick smooth enamel, are rarely the first to be attacked by caries. But the chemical agents concerned in the production of the disease may find access to the dentine through a fracture or imperfection of the enamel scarcely perceptible to the naked eye, and hence, the

disease is sometimes developed in a part not usually attacked by it.

Mr. Tomes believes that caries of a tooth is always preceded by loss of vitality in the affected part, and that it is not until this takes place, that the chemical agents, upon the action of which the structural alteration is produced, are capable of affecting the solid tissues of these organs. But that this opinion is erroneous is proven by the fact, that the animal frame-work of the affected part, after the complete decomposition of the earthy salts, is often so exceedingly sensitive, that the slightest touch of an instrument is productive of severe pain, thus demonstrating conclusively the existence of remaining vitality.*

The opinion of Mr. Lintott, with regard to the manner in which caries is produced, is founded upon the endosmotic phenomena which he thinks take place in the structure of a tooth. That endosmosis may take place in the outer part of a tooth is possible, and if so, the secretions of the mouth, if at all acidulated, would be likely to decompose the calcareous molecules with which they are brought in contact during their imbibition. But whether such action takes place or not, the structural alteration, beyond doubt, is produced by chemical agents.

The existence of an acid in the mouth, capable of decomposing the teeth, is conclusively proven by Dr. S. K. Mitchell, in a letter addressed by him to T. C. Hope, M. D., of Edinburgh, dated October 10, 1796. The fact may be demonstrated by a very simple experiment, which consists in moistening a piece of litmus paper with the buccal fluids obtained from between the teeth, where they have been retained until they have become vitiated. If this be done, the paper will be turned red. If, then, these fluids, when in a vitiated condition, are possessed of acid properties, they must necessarily exert a deleterious action upon the teeth, by decomposing and breaking down their calcareous molecules, or, in other words, causing their decay.

The acid detected by Dr. Mitchell was the septic, (nitrous,) but the acetic, lactic, oxalic, muriatic and uric have been detected in the saliva, in certain states of the general health. Donnè, who has analyzed the fluids of the mouth with great care, says, "The saliva, in its normal state, is alkaline, but the

* See *Tomes' Lectures on Dental Physiology and Surgery.*

secretions of the mucous membrane of the mouth are acid."* It is highly probable, therefore, that the acids which have been detected in the first of these fluids, may have been principally derived from the latter. Acidity of the saliva may, however, occur in certain morbid conditions of the general system. Donnè says, he has observed it in patients affected with gastritis, and in children with aphthæ. It is to the action of these acids upon those parts of the teeth, against which they are long retained, that caries is principally attributable.

The doctrine that the decay of the teeth is the result of the action of external corrosive agents, was first distinctly promulgated to the dental profession of the United States, about the year 1821, by Drs. L. S. and Eleazar Parmly. These agents may consist—of menstrua, formed by the decomposition of acetous fermentation of the remains of certain aliments, lodged in the interstices of the teeth; or of the fluids of the mouth, especially the mucous, in a vitiated or acidulated condition; or of acids administered during sickness, or used as condiments. According to the tables of elective affinity, there are but four acids which precede the phosphoric in their affinity for lime: namely, the oxalic, sulphuric, tartaric and succinic. It may hence be argued, that none of the other acids are capable of decomposing the teeth, or of injuring them in any other way, but daily observation proves the erroneousness of this conclusion. It has been shown by experiment that all the acids, both vegetable and mineral, act more or less readily upon these organs.† But we are disposed

* *Cours de Microscopie*, p. 209.

† The following experiments, made by Dr. A. Westcott, in 1843, assisted by Mr. Dalrymple, were repeated some years later, before the class of the Baltimore Dental College:

"1st. Both vegetable and mineral acids act readily upon the bone and enamel of the teeth.

"2d. Alkalies do not act upon the enamel of the teeth; the caustic potash will readily destroy the bone by uniting with its animal matter.

"3d. Salts whose acids have a stronger affinity for the lime of the teeth, than for the basis with which they are combined, are decomposed, the acids acting upon the teeth.

"4th. Vegetable substances have no effect upon the teeth till after fermentation takes place, but all such as are capable of acetic fermentation, act readily after this acid is formed.

"5th. Animal substances, even while in a state of confined putrefaction, act very tardily, if at all, upon either the bone or enamel. On examining the teeth subjected

to believe that caries of the teeth results more frequently from the action of some acid contained in the mucous fluids of the mouth, than from that of acid medicines or condiments, or even from such acids as may be generated by the acetous fermentation of particles of certain kinds of food lodged between the teeth. The author is of opinion, therefore, that if all the functional operations of the body were always healthily performed, caries of the teeth would seldom occur; for, in this case, the alkalinity of the saliva would be sufficient to neutralize the acidity of the mucous fluids of the buccal cavity, as well as any other acids generated in the mouth.

The foregoing theory of the cause of dental caries, explains the *rationale* of the treatment at present adopted for arresting its progress. By the removal of the decomposed part and filling the cavity with an indestructible material, the contact of those agents upon the chemical action of which the disease depends, is prevented, and the further progress of the decay arrested.

Among the indirect causes of caries, the following may be enumerated: depositions of tartar upon the teeth; a febrile or

to such influence, the twentieth day of the experiment, no visible phenomena were presented, except a slight deposit upon the surface, of a greenish slimy matter, somewhat resembling the green tartar often found upon teeth in the mouth.

"To give a more definite idea of the deleterious agents to which the teeth are exposed, and their consequent liability to be affected by them, we will notice the effect produced by a few of the individual substances, which are more or less liable to be brought in contact with the teeth.

"Acetic and citric acids so corroded the enamel in forty-eight hours, that much of it was easily removed with the finger nail.

"Acetic acid, or common vinegar, is not only in common use as a condiment, but is formed in the mouth whenever substances, liable to fermentation, are suffered to remain about the teeth for any considerable length of time.

"Citric acid, or lemon juice, though less frequently brought in contact with the teeth, acts upon them still more readily.

"Malic acid, or the acid of apples, in its concentrated state, also acts promptly upon the teeth.

"Muriatic, sulphuric and nitric acids, though largely diluted, soon decompose the teeth—these are in common use as tonics.

"Sulphuric and nitric ethers have a similar deleterious effect, as also spirits of nitre—these are common diffusible stimulants in sickness.

"Super-tartrate of potash destroyed the enamel very readily. This article is frequently used to form an acidulated beverage.

"Raisins so corroded the enamel in twenty-four hours, that its surface presented the appearance and was of the consistency of chalk.

"Sugar had no effect till after acetous acid was formed, but then the effect was the same as from this acid when directly applied."

irritable state of the body; a mercurial diathesis of the general system; artificial teeth improperly inserted, or made of bad materials; roots of teeth; irregularity in the arrangement of the teeth; too great pressure of the teeth against each other—in short, everything that is productive of irritation to the alveolo-dental membrane, or to the gums.

The doctrine here advocated is one, which, we confess, we were for a long time unwilling to believe, because it was opposed to all our earlier preconceived notions upon the subject; but long and attentive observation has forced us to acknowledge its truth.

It will be perceived, from the foregoing exposition of the causes of dental caries, that three distinct theories have been advanced upon the subject, namely: 1. The *vital*, as advocated by Paré, Fox, Bell, and some others. 2. The *chemical*, as maintained by nearly all French authors, by Salmon, Drs. L. S. and E. Parmly, and by almost all late writers. 3. The *chemico-vital*, of Tomes. We might also add the *endosmotic* theory of Lintott, which, in fact, is nothing more than an explanation of the supposed manner in which chemical agents are brought into more direct contact with the earthy salts of a tooth.

PREVENTION OF CARIES.

It is an old adage, no less true than trite, that "an ounce of prevention is better than a pound of cure," and in the present instance it may be applied with its full force. Were more attention paid to the practical instruction thus conveyed, many of the diseases of the teeth might be avoided. Most of the remarks that might be made on this subject have been anticipated; consequently, it will only be necessary to observe, that if the teeth are well formed and well arranged, all that will be required, is to keep them clean; if any irregularity occurs, it should be remedied by the means before described.

For cleansing the teeth, the regular and frequent use of a brush and waxed floss-silk will, in most cases, be sufficient. The enamel should be kept free from all stains and discolorations, by the employment, if necessary, once a day, of a dentrifice; either of the following may be used:

℞;

Prepared chalk	℥iv.
Powdered orris root	℥iv.
Powdered cinnamon	ʒiv.
Sup. carb. of soda	ʒss.
White sugar	℥i.
Oil of lemon	gtt. xv.
Oil of rose	gtt. ij.

℞;

Prepared chalk	℥ij
Powdered orris root	℥ij.
Pumice stone	℥j.

Ingredients in both prescriptions to be thoroughly pulverized and well mixed.

The importance of keeping the teeth clean cannot be too strongly impressed upon the mind of every individual. Proper attention to the cleanliness of these organs contributes more to their health and preservation than is generally supposed. Against caries it is a most powerful prophylactic. "Where the teeth," says Dr. L. S. Parmly, "are kept literally clean, no disease will ever be perceptible. Their structure will equally stand the summer's heat and winter's cold, the changes of climate, the variation of diet, and even the diseases to which the other parts of the body may be subject from constitutional causes."

The configuration and arrangement of some teeth is such, however, as to preclude the possibility of keeping them clean; but this should not deter any one from using the proper means, for if disease is not wholly prevented, they will, at least, contribute very greatly to the preservation of the organs.

TREATMENT OF CARIES.

Although the physical condition of the teeth is sometimes such as to render them exceedingly susceptible to the attacks of caries, there is no disease to which the body is liable, that can be treated with a more certain prospect of success than this. If taken in time, it can almost always be arrested; that in the majority of cases it is not, is attributable more to want of skill on the part of the dentist, than to the incurable nature of the disease. The treatment, to be effectual, must be thorough, and there is no branch of manual medicine that requires more judgment, or a greater amount of skill, than the one within whose province the treatment of the disease under consideration comes.

As a general rule, before any treatment is instituted for the purpose of arresting its progress, the gums and alveolo-dental periosteum should be in, at least, a tolerably healthy condition;

for if they are inflamed, or ulcerated, or in a highly irritable state at the time, the most skillfully applied remedies may prove unavailing. If, therefore, these structures are diseased, such treatment as may be necessary to their restoration, and which will hereafter be described, should first be had recourse to.

The treatment for arresting the progress of caries consists of two operations—filing and filling. The first is for superficial caries on the lateral or approximal surfaces of the teeth, and as preparatory to the other, when the disease is situated in the sides of the organs. The second is for deep-seated caries, and the manner of performing each will be described in the two following chapters.

CHAPTER SECOND.

FILING TEETH.

There is no operation in dental surgery, against which a stronger or more universal prejudice prevails, than that of filing the teeth; yet, when judiciously and skillfully performed, there is no one more beneficial, or effectual in arresting the progress of caries. Thousands of teeth are every year rescued from its ravages, and preserved through life, by it. But, although it is productive of so much good, it is also, in the hands of ignorant and unskillful operators, productive of incalculable injury.

With regard to the merits of this wrongly-judged and much-abused operation, the author's views are so fully expressed by the late Dr. John Harris, in a paper published in the September No. of vol. 5, of the American Journal of Dental Science, that he cannot do better than quote his remarks upon the subject.

He says, "Filing the teeth is one of the most important and valuable resources of the dental art; it is one that has stood the test of experience, and is of such acknowledged utility, as to constitute of itself, in the treatment of superficial caries on the lateral surfaces of the teeth, one of the most valuable operations that can be performed on these organs. And even after caries, in the localities just mentioned, has progressed so far as to render its removal by this means impracticable or improper, the use of the file, in most cases, is still necessary, in order to the successful employment of other remedial agents. But in either case, a failure to accomplish the object for which it is used, would only be equivalent to doing nothing at all.

"The use of the file, then, may very justly be considered a *sine qua non*, for the removal of superficial caries from the sides of the teeth which come in contact with each other, as can be attested by thousands of living witnesses; and in preparing the way, in deep-seated caries, for the thorough removal of the disease, and filling, successfully, the cavity thus formed.

"In a paper written by myself, some eleven or twelve years ago, upon this subject, I contended that filing the teeth was not necessarily productive of caries, and my subsequent experience and observations have only tended to confirm the correctness of the opinion which I then advanced, and I cherish the belief that this opinion will not, at this time, conflict with the views of the more enlightened of my professional brethren.

"But when reference is had to the physical peculiarities of the teeth, it will at once be perceived, that they present a strange departure from the laws that govern and control all other parts of the body; and these organs, when diseased, can only be restored to health and usefulness by art, unaided by the sanitary powers of nature. Hence it is, that most of the operations upon them will not, like those in general surgery, admit of mediocrity in their performance.

* * * * * * *

"The fact that the crowns of the teeth are covered with enamel, is alone sufficient evidence of its importance and utility in shielding and protecting the bony structure which it envelops from mechanical and morbid influences; so that it would seem that its removal or loss would necessarily expose the organs to certain destruction. But we have satisfactory evidence, that teeth, after having suffered the loss of large portions of the enamel, have been restored to health, and preserved for many years, and often through life.

"The rapidity with which caries progresses after the exposure of the bone by the loss of the enamel, depends upon the physical peculiarities of the teeth, and upon local and constitutional influences; hence the difficulty, and oftentimes impossibility of obtaining the object for which dental operations are instituted, while such influences are suffered to exist. If special regard is not had to the curative indications, most, if not all the operations upon the teeth, which have for their object their ultimate preservation, are sure, to a greater or less extent, to augment all of the previously existing local affections, by increasing the irritability of the parts, and by rendering them more susceptible of being acted upon both by local and constitutional causes.

"Without indulging in further prefatory remarks, I shall proceed to notice more particularly the subject under consideration.

And I would here observe, that an experience obtained from twenty-three years' constant practice, has fully convinced me, not only of the propriety, but of the absolute necessity in the treatment of caries in the lateral surfaces of the teeth, of employing the file. There is no instrument so well adapted as this for the removal of the disease when situated in these parts of the teeth, especially when the organs are in close proximity with each other; or for the removal of rough and weakened edges of the enamel in deep-seated caries, and for making sufficient space or room for the removal of the diseased parts preparatory to plugging.

"It may be laid down as a rule, from which exceptions should never be taken, that the file should not be used, while the teeth or their contiguous parts are suffering general or local, acute or chronic, inflammation. Therefore, when this is the case, the treatment of the general and local affections should precede the operation of filing. Upon the removal of all the acute or chronic diseases of the mouth greatly depends the success of the dentist in the treatment of affections of the teeth, calling for the employment of the file. As much importance, therefore, is to be attached to an enlightened and discriminating judgment, as to tact in the performance of the operation.

"In fact the removal of all local causes of irritation—such as dead roots of teeth, teeth occasioning alveolar abscesses, or such as exert a morbid influence upon the surrounding parts, and all depositions of salivary calculus or other foreign matter—should precede all other operations upon these organs.

"The length of time necessary for the restoration of the parts contiguous to the teeth, may vary from a few days or weeks to as many months, depending upon the nature and extent of the disease, the general health of the patient, and the constitutional as well as local treatment to which they are subjected.

"In assuming the position, that filing the teeth does not, of necessity, cause them to decay, it is by no means to be inferred, that the operation can, in all cases, and under all circumstances, be performed with advantage or even impunity. Its effects, like those of most other operations upon the teeth, when the curative indications are disregarded, or not properly carried out, are most injurious. The employment of the file at an improper time,

and in an improper manner, increases the liability of teeth to decay; it augments the irritability of all the parts adjacent to them, and consequently their susceptibility of being acted upon by local and constitutional causes.

"The principal, and, I believe, only objection, urged against filing the teeth, is based upon the erroneous opinion, that the loss of any part of the enamel of these organs must necessarily result in their destruction. But, if this be true, why is it, as I have on another occasion asked, that the negroes of Abyssinia have such sound teeth as they are represented to have; since it has long been a custom with them to file all their front teeth to points, so as to make them resemble the teeth of a saw or those of carnivorous animals? Of course, large portions of the enamel and much of the bony structure, must be removed in the operation, yet we are credibly informed that their teeth seldom decay. The same may be said of the Brahmins of India, who, from remote ages, have been in the habit of using the file; principally, I believe, for separating their teeth, yet they too are noted for having fine teeth. I might refer to the people of other countries, with whom the same practice has long had an existence, but it is unnecessary to go abroad for proof, when we have such an abundance of it at home, to establish the propriety and absolute necessity for the practice I am now advocating.

"With the people just referred to, it is evident that they file, principally, for the purpose of ornamenting their teeth; we use it only as a remedial agent in the treatment of disease. The reason why their teeth are not so subject to disease as are those of the inhabitants of civilized countries, is attributable to the difference in their habits of life, mode of living, and to the absence of the causes productive of the various diseases peculiar to civilization and refinement.

"Notwithstanding the utility and value of the operation, filing the teeth may be regarded as a predisposing cause of caries. If this be true, it may be asked, why file at all? I answer, in this country, owing to the prevalence of the immediate or direct cause of caries, the operation is only performed as remedial, for the purpose of removing actual disease or as preparatory to plugging. It does not, of necessity, follow, that caries of the teeth, after having been judiciously removed or treated, although the organs

be predisposed to the disease, will ever again occur. The general system often escapes the development of those diseases to which it is predisposed through life; so also do the teeth. If the operation be properly performed, and the filed surfaces kept thoroughly clean, a recurrence of the disease, notwithstanding the increased predisposition thus induced, will never take place. The immediate cause of dental caries being the contact of corrosive agents with the teeth, the necessity for this precaution is obvious. The bony structure of these organs is more easily acted upon by such causes, than the enamel; for this reason, when it becomes necessary to expose it with a file, for the removal of disease, it should be done in such a way as to admit of its being kept thoroughly and constantly clean; so that, if it afterwards becomes carious, it will be owing altogether to inattention of the patient. In view of this, whenever it becomes necessary to file the teeth, whether for the complete removal of caries, or as only preparatory to plugging, we should always impress upon the patient the importance of cleansing the surfaces thus operated upon, at least three or four times every day. The future preservation of the organs will depend upon the constant and regular observance of this precaution, especially when they are of a soft or chalky texture, for they are then far more easily acted upon by decomposing agents than when hard.

"The cases requiring the use of the file vary so much, that it would be difficult to lay down precise directions with regard to the extent to which the operation should be carried. This must be determined by the judgment of the operator. The design of the operation may be defeated either by filing too much or too little. Either extreme should be avoided; but it is my opinion, that by far the greater number of unsuccessful results are attributable, rather to the too moderate, than to the too great use of this instrument; especially, where the circumstances of the case have nothing to do in determining the result.

"It is not my object to describe the manner in which teeth should be filed, but merely to offer a few general remarks on the advantages that result from it when the operation is judiciously performed; also to show that it is from the abuse of the file, in the hands of the ignorant and inexperienced practitioner, that its merits have been so often erroneously estimated. It will be

perceived, from the foregoing remarks, that its utility depends upon carrying out all the curative indications, and that it should never be resorted to except in the absence of disease in the parts with which these organs are immediately connected. Therefore, to estimate the merits of the operation correctly, we should know all the circumstances under which it has been performed, the competency of the operator, and whether he was permitted the free exercise of his judgment. The dentist is often called upon to render his services, where, from the timidity or ignorance of his patient, he is, if he consents to operate at all, so restricted in the application of his remedies, that little if anything more than temporary relief can be afforded. And cases may occasionally occur, in which, from unforeseen circumstances, even after the most skillful management, the dentist may be disappointed in his expectations, and fail in the attainment of the object for which his services were solicited."

It is scarcely necessary to give any directions with regard to the manner of holding the file. In filing the front teeth and those on the right side of the mouth, the operator should stand to the right and a little behind the patient, in order to steady the head, as it rests against the back of the operating chair, with his left arm; while with the fingers of the left hand the lips are raised and the teeth properly exposed for the operation. In filing the teeth on the left side of the mouth it may be necessary for the operator to stand upon the left side of his patient. The file, firmly grasped between the thumb and middle finger of the right hand, with the end of the forefinger resting upon its outer end, should be moved backward and forward in a direct line, as any deviation from this would immediately snap the instrument. The first opening between the teeth, when the approximal edges of the two are carious, should be made with a flat file, about one-fourth of a line in thickness, cut on both sides and both edges; this done, a file cut on one side and both edges should be employed for the completion of the operation. If only one tooth is decayed, the operation may be commenced and completed with a safe-sided file. The file, during the operation, should be frequently dipped in water, to prevent it from becoming heated or clogged while in use; having the water warm or tepid where the teeth are sensitive. When the file becomes so much clogged

that the water or a brush will not cleanse them, a brass or steel scratch-brush may be used, or they may be dipped in sulphuric or chlorohydric acid, and then washed with the greatest care to remove every trace of acid.

Fig. 75.

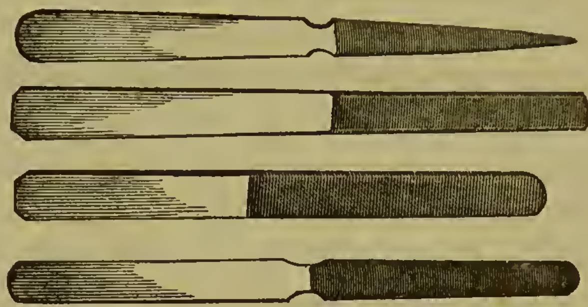


Fig. 75 represents various forms of the thin separating file.

To secure the success of the operation, it is sometimes necessary to file away a considerable portion of the tooth; but in doing this, the operator should be careful not to destroy the symmetry of the labial surface. The aperture, anteriorly, should only be wide enough to admit of a free oblique or diagonal motion of a safe-sided file of about one-fourth of a line in thickness. In this way, one-fourth or more of a tooth may be removed without materially altering its external appearance. But a tooth should not be filed entirely to the gum; a shoulder should be left to prevent its approximation to the adjoining tooth. Sometimes the decay is of such size and so situated, that it may be removed by means of enamel chisels and scrapers with less alteration in the external or labial surface of the tooth. These very valuable instruments will also be found useful for rapid cutting preparatory to the slower action of the file. A rounded form can be given by them to the inner angles of the teeth, for which purpose they may either follow or take the place of the file.

When the decay occupies a large portion of the approximal surface, and has penetrated into the tooth to a considerable depth, destroying the enamel anteriorly, and causing it to present a ragged and uneven edge, it will be necessary to form a wider exterior aperture than mere regard for appearance would dictate. When the approximal surfaces of the two front teeth are affected with caries, about an equal portion should, if circumstances permit, be filed from each tooth. In the case of delicate front teeth or teeth slightly loose in their sockets, it will

be well before filing to mould a small piece of gutta-percha around or against the inner surfaces of the tooth to be filed and several adjoining ones. It gives support to frail teeth, and greatly lessens the danger of irritation from the motion imparted by the file to teeth which are not firmly set in their sockets. Some use for this purpose plaster; but we think the gutta-percha, as suggested by Professor Gorgas, will be found altogether more conveniently applied and more agreeable to the patient.

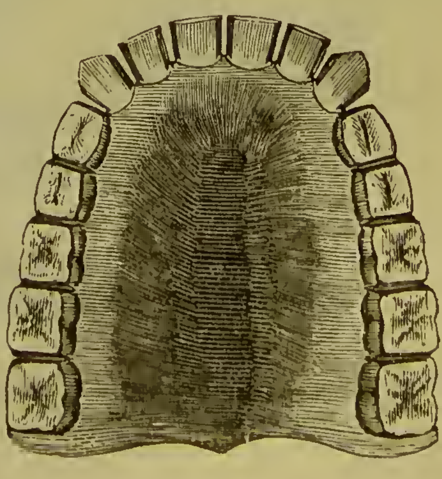
Fig. 76 represents a front view of the superior incisors and cuspids after having been filed, showing the shoulder left near the gum; which, however, should not have the sharp angle represented in the drawing. To prevent this, the operation may be completed with a round-edged separating file or else with a delicate mouse-tail file.

Fig. 76.

After a sufficient portion of the tooth has been filed away, the surface should be made as smooth as possible with a very fine or half worn file, or with Arkansas stone, finishing with pumice-stone or powdered silex, applied upon a piece of cord, tape, or suitably shaped piece of hard, tough wood. All edges and sharp corners should be rounded and made smooth, and when the operation is completed, the patient should be directed to keep the filed surfaces perfectly clean; for if the mucous secretions of the mouth, or extraneous matter is permitted to adhere to them, a recurrence of the disease will take place.

In Fig. 77 is represented a posterior view of the superior incisors and cuspids after having been filed; also, of the bicuspids and molars after having been subjected to the same operation.

Fig. 77.

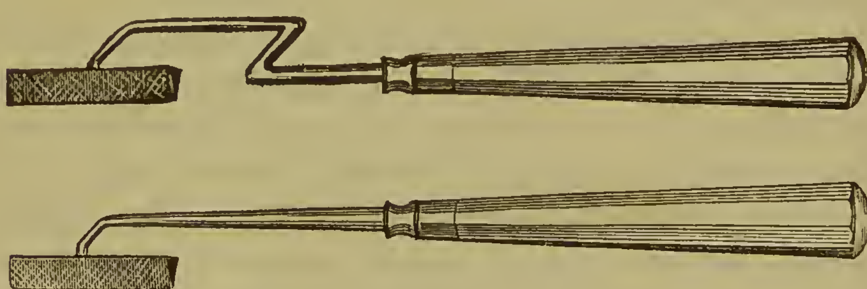


In separating the bicuspids, a space should be made somewhat in the form of the letter V; it should not, however, form an acute angle at the gum; for its formation a file, shaped like a clockmaker's pinion-file, or one that is oval on one side and flat

on the other, will be found most suitable. A space shaped in this manner will prevent the approximation of the sides of the teeth, and if filling be necessary, it will enable the operator to do it in the most perfect manner.

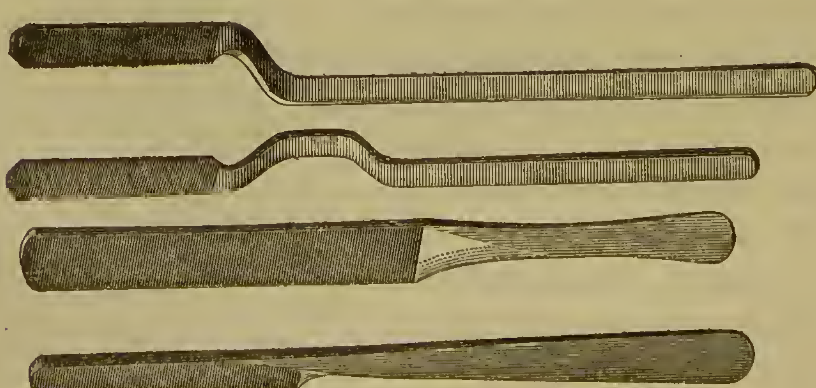
When the separation of the molar teeth becomes necessary, the same shaped space should be formed. But as these teeth are situated far back in the mouth, it cannot often be done with a straight file; to obviate this difficulty, an instrument, with which every dentist is acquainted, denominated a file-carrier, is usually employed. But in consequence of the difficulty of procuring instruments of this kind, exactly suited to holding files of the right shape, the author, a few years ago, sent some file patterns to Stubs' manufactory, in England, and had files made, which he found to answer his fullest expectations. These files (Fig. 78), are shaped something like a pinion file: they are an inch

Fig. 78.



and a half long, and have a handle of about six inches in length, bent in such a manner that the instrument may be used between the molar teeth without interfering with the corners of the mouth. They are in pairs—one for the right and one for the left side of the mouth. Two patterns are represented; the

Fig. 79.

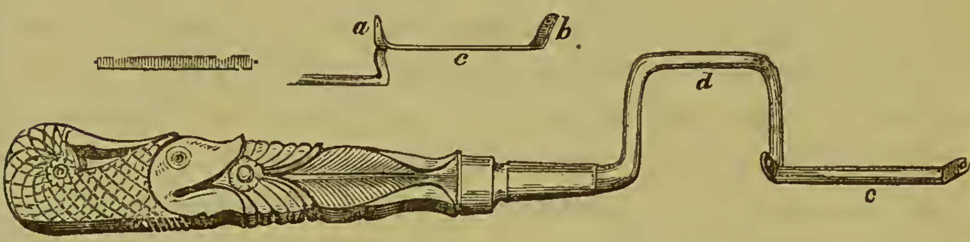


upper, in consequence of the handle being on a line with the file, works more easily than the lower one.

A great variety of V shaped separating files are now to be found in the dental depots, from English, French, and American manufacturers. Fig. 79 will give a correct idea of some of these shapes.

Fig. 80 represents a very useful file-carrier invented by Dr. A. Westcott: *c* is a spring, and through the arms *a* and *b*,

Fig. 80.



there are square mortices to receive the ends of the file and to keep it from turning. The arm *b* comes off at an obtuse angle. The *file* is prepared by making each end square, corresponding with the size of the mortices in the arms, and is adjusted to the carrier by first putting one end of the file into the arm *a*, and pressing down the other end into the mortice *b*; the spring, constituting that portion of the instrument between the arms, yields sufficiently to admit of this. It is so constructed that the handle is brought on a line with the file—consequently two are required, one for each side of the mouth.

Fig. 81.

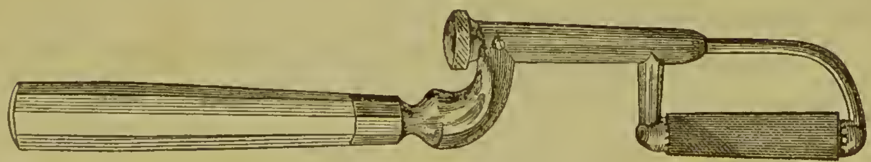


Fig. 81 represents an excellent file-carrier, in which the file can with ease be set at any required angle, and will suit either side of the mouth.

CHAPTER THIRD.

FILLING TEETH.

This is one of the most difficult operations the dentist is called upon to perform; it often baffles the skill of operators who have been in practice many years. It is advisable only under certain circumstances, and when the operation is performed without due regard to these, it may be productive of injury rather than benefit. It is the only certain remedy that can be applied for arresting the progress of deep-seated caries; but to be effective, it must be executed in the most thorough and perfect manner. The preservation of a tooth may be regarded as certain when well filled, and with a suitable material, if it be afterwards kept constantly clean. At any rate, it will never again be attacked by caries in the same place.

On this highly important operation, Dr. E. Parmly thus remarks: "If preservation is as good as a cure, this is as good as both; for the operation of stopping, when thoroughly performed, is both preservation and cure. And yet it must never be forgotten, that this assertion is true only in those instances in which the operation is well and properly done; and, perhaps, it is imperfectly and improperly performed more frequently than any other operation on the teeth.

"There are reasons for this fact, into which every ambitious and honorable practitioner will carefully inquire. Although the books are explicit on this point, I deem it sufficiently important to deserve a few additional remarks. The following considerations are essential, and, therefore, indispensable to success in this department of practice. *Firstly*—The instruments used must be of the proper construction and variety. *Secondly*—The metal employed must be properly prepared as well as properly introduced. *Thirdly*—The cavity which receives the metal, must be so shaped as to retain it in such a manner as to exclude not only solids, but all fluids, and even the atmosphere itself.

Fourthly—The surface of the metal must be left in such condition as to place it beyond the reach of injury from food and other mechanical agents with which it necessarily comes in contact. *Fifthly*—The tooth thus stopped should be free from pain, and every known cause of internal inflammation."

It is important that the operation be performed before the disease has reached the pulp cavity; after this, the permanent preservation of the tooth may be regarded as more or less questionable. Still, under favorable circumstances, the author believes it may, in the majority of cases, be performed with success. But, as the propriety and manner of filling a tooth after the pulp has become exposed, will hereafter come up for special consideration; as well, also, as the operation of filling the pulp cavity after the destruction of the pulp; it will not be necessary to enlarge upon these subjects at this time.

A tooth is sometimes exceedingly sensitive when the nerve is not exposed; but this need not deter the operator from removing the decayed part and filling the cavity, as the only inconvenience it will occasion the patient, will be a little suffering during the operation, and slight momentary pain for a few days, whenever any thing hot or cold is taken into the mouth. But when the sensibility is so great that the patient cannot bear the removal of the diseased part, as occasionally occurs, it may be allayed by the application of chloride of zinc to the cavity of the tooth, for from three to six minutes. When this is done, care should be taken to prevent it from coming in contact with any of the soft parts of the mouth, on account of its active escharotic properties. The fortieth or fiftieth part of a grain of arsenic is sometimes applied, but there is great danger of destroying the vitality of the pulp by the use of this agent, even though it be permitted to remain for only a few hours. Cobalt is said to be less dangerous and equally efficacious.

Chloroform applied to the cavity on a small piece of cotton will often give a temporary insensibility, and has the merit of being quite harmless; which cannot be said of chloride of zinc, arsenic, or cobalt—the first sometimes acting injuriously upon the dentine, the two latter upon the dental pulp. The safest and perhaps best way of meeting the difficulty, is to have the excavators very sharp and well tempered, and to cut firmly and

decidedly; for the scraping of a dull instrument is quite as painful as the cut of a sharp one.

Again, this acute sensitiveness of dentine is due to the presence of nerve fibres, as conjectured by Dr. Maynard, and demonstrated by Professor Johnston (see page 50); therefore, we shall save the patient much suffering by making the first strokes of the instrument in such direction as to sever these fibres, as recommended by Dr. Maynard.

MATERIALS EMPLOYED FOR FILLING TEETH.

Among the articles which have been employed for filling teeth, are gold, platina, silver, tin, lead; fusible alloys of tin, lead, bismuth and cadmium; amalgams, gutta percha, oxy-chloride of zinc, and various preparations of the gum-resins. Of these no single one can be said to unite all the requirements of a perfect material for filling, which may be enumerated:—1. Resistance to the mechanical action of mastication. 2. Resistance to the chemical agencies of the mouth. 3. Facility of introduction and consolidation. 4. Harmony of color. 5. Absence of all galvanic, chemical or vital action upon the teeth or the general system. 6. Absence of all heat-conducting property.

Gold Foil.—To the use of this material, when properly prepared, there is the least possible objection: perfectly answering the first, second, and fifth requirements; to a great extent the third, if in skillful hands; but deficient in the fourth and sixth. It is the only one, in the opinion of the author, which should ever be employed for the permanent filling of teeth. No better material is wanted for the operation. A tooth may be so filled with it as to secure, in almost every case, its permanent preservation. It should, however, be perfectly pure, be beaten into thin leaves, and well annealed before it is used. When prepared in this manner, it may be pressed into all the inequalities of the cavity, and rendered so firm and solid as to be impermeable to the fluids of the mouth.*

* It would seem from what Fauchard says upon the subject, (*Le Chirurgien Dentiste*, tome 2, pp. 68–70,) that this metal, to some extent at least, has been used for filling teeth for a long time. Although he gives the preference to tin and lead, on account

Although there may be no difference in the purity of the gold, and the thickness of the leaves; yet a marked difference will be found to exist in the malleability and toughness of the foil of different beaters. The art of preparing gold for filling teeth is an exceedingly nice and difficult one, and is believed to have attained greater perfection in the United States than in any other country; at least this fact is so generally admitted, that many of the most eminent European practitioners procure nearly all they use from Mr. Charles Abbey, of Philadelphia, the oldest manufacturer in America. There are, however, many other gold beaters in the United States who manufacture gold foil of a very excellent quality.

The thickness of the leaves is determined by the number of grains each contains, and is designated by numbers on the books, between the leaves of which they are placed, after having been properly annealed. These numbers range from 4 to 20. The weight of the leaves, generally, varies two grains, so that the numbers run, 4, 6, 8, 10, and so on up to 20. A book containing a quarter of an ounce of No. 4, will have thirty leaves in it. Some dentists use foil varying in Nos. from 4 up to 20, while others confine themselves to a single number. If but one number be used, 4 will, perhaps, be found better than any other. The author has used Nos. 4, 6, 8, 10 and 15, but he prefers the first, and is decidedly of opinion, that in a large majority of cases, a better filling can be made with it than any of the others. There may be cases in which higher numbers can be more advantageously employed; as for instance in fang filling, and in cavities which are either *very* large or *very* small.

Foil manufactured from sponge or crystalline gold, is so adhesive, that any number of pieces may be welded one to another; thus a part, or even the whole of the crown of a tooth, may be built up with it. The same properties may also be imparted to foil manufactured in the ordinary way, by re-annealing. This property is peculiarly valuable in many cases where it becomes necessary to build up a large portion of the crown of a tooth;

of the greater malleability of these metals, he speaks of gold as being used by other dentists. But the operation of filling teeth, at the time this author wrote, was very imperfectly understood, and the gold then employed for the purpose must have been so badly prepared as to render its use exceedingly difficult.

but when it is used, instruments having serrated points are required, like those employed in the use of crystalline gold. But for filling ordinary cavities in teeth, this property is of no advantage; indeed, for filling a deep cavity, having an orifice no larger than the bottom, it is objectionable, as more time and labor is required to reach the same point of excellence with it, than with foil such as is usually obtained from the best manufacturers.*

Sponge or Crystalline Gold has recently been employed by some dentists for filling teeth. The author has used it in a number of cases with very satisfactory results. Since the publication of the fifth edition of this work, the properties of crystalline or sponge gold have been more thoroughly and extensively tested, and the result, especially with the last named preparation, has fully confirmed the favorable opinion entertained by us with regard to its value. Those who have had most experience in the use of it, say it is superior, in many cases, to foil. The author is acquainted with several of the most skillful operators in the United States, who have used it almost exclusively in their practice for several years; and has seen fillings made by some of these gentlemen, which for beauty and solidity he does not think could be surpassed. He has also himself made some fillings with this material, which he believes it would be impossible to make with ordinary gold foil. The crystals possess the property, when pressed firmly against each other, of welding and becoming as solid and almost as incapable of disintegration or crumbling as a piece of bullion or coin. This property enables a skillful manipulator to supply almost any loss which a tooth may have sustained, even to the building up of an entire crown. Still it will never supersede the use of non-adhesive gold foil, as there are many cases in which the latter can be used more advantageously and with more facility than the former. Nor will the employment of it, in the opinion of the author, ever become universal; for the reason that more care and skill are required to

* Adhesive gold foil has been known to some dentists for many years, but Dr. R. Arthur was the first to describe the proper manner of using it (A treatise on the Use of Adhesive Gold Foil, 1857). He claims that the same point of excellence can be attained with it as with the best preparations of crystalline gold.

make a good filling with it than with leaf-gold, especially when the cavity in the tooth is difficult of access. Filling with crystal gold or adhesive foil, especially the latter, is more tedious than the same operation with ordinary foil. Again, the necessity of excluding saliva from the filling during the operation is imperative; for the slightest moisture destroys the adhesiveness of the material, upon which depends the success of the operation.

Experiments have been made with *silver*, *platina* and *aluminium;* but with unsatisfactory results. They are less malleable than gold, and therefore cannot be made so thin; at the same time they have not the softness of tin; hence they work harshly under the plugger. But for this, platina would prove a very valuable material. An additional objection to silver is its liability to undergo chemical change, being in this respect greatly inferior to pure tin. The peculiarity of aluminium, in this relation, is the impossibility of welding its leaves by pressure: even under the gold beater's hammer it forms loose scales which no annealing can make adherent.

Tin Foil.—This, when chemically pure, and properly prepared, is less objectionable for filling teeth, than most of the articles hereafter enumerated. Under favorable circumstances, if skillfully introduced, it will prevent the recurrence of caries. But if the fluids of the mouth are vitiated, it soon oxidizes and turns black; and then, instead of preventing, it rather promotes a recurrence of the disease. This, with the author, has constituted an insuperable objection to its use. As an excuse for its employment, however, many operators say, that in consequence of its greater softness, it can oftentimes be employed for filling a badly-shaped and large cavity where gold cannot be used. We do not, however, regard this as a valid objection; for any tooth that can be filled with tin, can be equally well filled with gold. Others again employ it, because many of their patients are not able to pay for a more costly material. Now, if a tooth is worth filling at all, it is worth filling in a proper manner, and with a suitable material, and it would be more creditable to the operator to divide the expense with his poor patient, than to use an article that may never benefit him.

Lead is far more objectionable than tin, as it is more easily

decomposed by the secretions of the mouth; its introduction into the stomach might be productive of serious injury to the general health of the patient. But, happily, this article is now seldom used, except by the most ignorant and lowest class of empirics.

D'Arcet's Metal, an alloy of tin, lead and bismuth was once empirically used in a fused state. But two serious objections compelled its abandonment. The high temperature (212°) caused great pain and excited inflammation. If from this cause the tooth was not lost, the shrinkage of the metal on cooling admitted moisture into the cavity and the decay progressed.

The attention of the profession has recently been called to a somewhat similar alloy, discovered by Dr. B. Wood. The feature of Dr. Wood's discovery is the remarkable property of cadmium in reducing the fusion point of the fusible alloys. This overcomes in good measure the first objection against D'Arcet's metal, and the second perhaps altogether. It may be introduced in properly sized pieces, cold; then made plastic and pressed to place with blunt instruments suitably shaped and heated to the proper temperature. Over a sensitive pulp, a layer of non-conducting asbestos may be interposed. The merits of this application of Dr. Wood's otherwise very valuable discovery, have scarcely had a sufficient test. We cannot speak from any experience in its use; but should think that it might be experimented with in certain cases, where the use of gold is inadmissible, and where there is little or no danger of irritation from the elevated temperature necessary to its use.

Amalgam, also known by the name of *mineral cement*, or *lithodeon*, is the most pernicious material that has ever been employed for filling teeth. It almost always oxydizes in the mouth, turning the teeth black, and often hastens their destruction. When used in considerable quantity, it is apt to exert a deleterious effect upon the alveolo-dental membranes, gums, and other parts of the mouth.

In the first edition of this work, the author expressed his disapprobation of the employment of this article; since which time he has had abundant opportunity of observing its effects, and is fully confirmed in the unfavorable opinion which he then ex-

pressed with regard to it. Several decided cases of salivation, occasioned by the use of it, have fallen under his observation.

Some have endeavored to obviate the objections existing to its use, by employing silver perfectly pure ; but it matters not how pure this metal may be, the amalgam is equally deleterious in its effects, for the mercury is the mischievous ingredient.

The amalgam most recently approved by its advocates is made by mixing mercury with filings of an alloy of silver and tin. Great care is used to press out all excess of mercury through buckskin, and to wash out all the oxide in alcohol, &c. Its friends claim for it, thus carefully prepared, that it will not often blacken the teeth, and that very little if any free mercury can escape into the tooth or the mouth.

That it is a very convenient material; can be put where gold cannot; becomes very hard and may last for many years, we doubt not; but nothing we have seen, read, or heard, can persuade us that the profession would not have been benefited if mercurial amalgams had never been known.

Gum Mastic, at one time much used, is now seldom employed, except as a temporary filling when the pulp of the tooth is exposed; even for this purpose it requires to be often renewed, as it is soon dissolved by the saliva.

An alcoholic solution of *Gum Sandarach* or *Mastic*, is sometimes used to retain arsenical preparations in the cavity for the destruction of a nerve. A piece of cotton saturated with the solution is readily introduced, hardens quickly, and may keep its place for several days if required.

Gutta Percha is an excellent material for temporary fillings. It may be made harder, whiter and less contractile by incorporating with it some very fine powder of feldspar, silex, lime or magnesia. A very excellent preparation known as *Hill's stopping* is made by mixing gutta percha with as much of the following powder as it will hold without becoming brittle—quicklime, two parts, very fine quartz and feldspar, one part each. Of all temporary fillings this is probably the best yet known.

A mixture of chloride of zinc and oxide of zinc, has been lately much used under the various names of *oxy-chloride of zinc*,

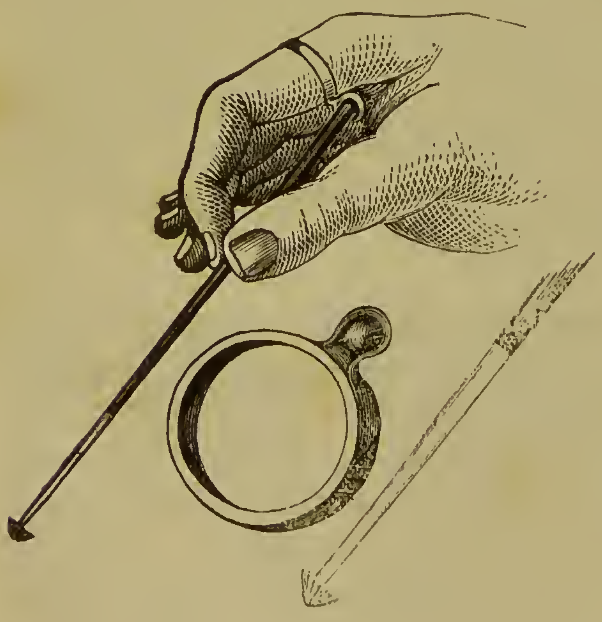
osteo-dentine, osteo-plastic, mineral paste, &c. Quackery has seized it with eagerness and plastered up many teeth with a mortar even more conveniently used than amalgam. The chloride in it will injure the tooth substance in some cases. It may last for some time in a cavity, but it often crumbles away in a few weeks or months. Still as a *temporary* filling it may, if employed with caution and judgment, be found useful, and for certain cases very valuable.

INSTRUMENTS FOR FORMING THE CAVITY.

For the removal of the diseased part of a tooth, and the formation of a cavity for the proper reception and retention of a filling, a variety of instruments are required, which should be constructed of the best steel, and so tempered as to prevent them from either breaking or bending. Their points should be so shaped, that they may be conveniently applied to any part of a tooth, and made to act readily upon the portion which it is necessary to remove.

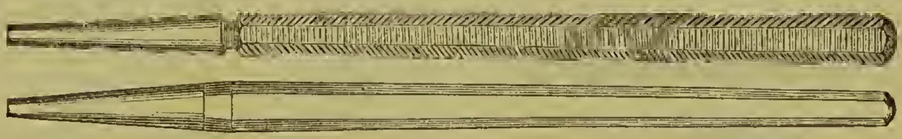
The instruments employed for this purpose are called excavators. They may be formed either with handle and point in one piece; or fitted to separate handles made of wood, ivory, pearl or cameo; or be made to fit into one common socket handle. Those having separate handles are more convenient than the others, but it would be well for every practitioner to be provided with a number of each kind. Steel-handled excavators are cheaper than wooden or ivory-handled ones; but if small they are not so easily grasped, and if large they become too heavy. The handle best suited for delicate manipu-

Fig. 82.



lation is made of cocoa or ebony, largest an inch above the ferule, and tapering both ways. The principle of construction is to give sufficient size for the fingers to hold it securely, and to lessen the weight at the end of the handle. Socket handles are useful for those who wish compactness of apparatus; also for those who are in the habit of pointing their own instruments. Fig. 83 represents such an instrument: the lower one made of

Fig. 83.



ivory, ebony or cocoa, will be found very valuable. Its shape might be better suited to some operators if made somewhat larger just above the ferule.

The flat and burr-headed drills are very useful for enlarging the orifice of a cavity. The pressure of the instrument against the hand, between the thumb and fore-finger, is often productive of much irritation. To prevent which, a socket ring or shield like the one represented in Fig. 82, invented by Dr. Westcott, may be used with advantage. It consists of a ring adapted to the fore or middle finger, with a small socket attached to the inside.

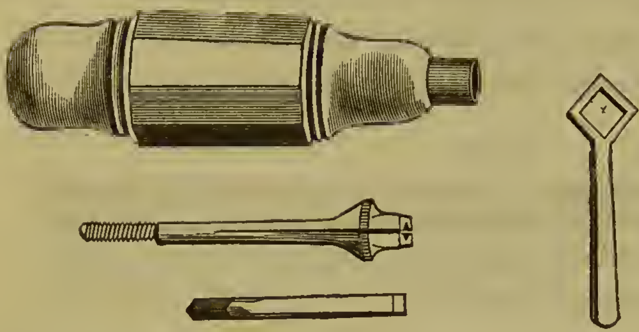
The author uses an open ring like the one represented in Fig. 84, with an arm a little more than an inch in length attached, having a socket at the extremity resting in the hollow of the hand, between the thumb and fore-finger. This he finds much more convenient, as it enables him to apply more pressure upon the instrument without irritating the finger, and as the ring is open, it adapts itself more readily to it.

Fig. 84.

A socket handle may also be used for drills as for excavators. It may be shaped like the excavator socket (Fig. 83), with the end of the handle pointed so as to fit into the ring (Figs. 82, 84); or it may have a flattened, revolving head. The bits may be fitted either by firmly pressing them into a simple round socket, or a trigger socket may be used.

Dr. Forbes has adapted to enamel burrs, chisels and gouges, an ingenious handle, which, by the simple turning of a small wrench, secures the square-cornered bits very firmly (Fig. 85). The principle may be applied to handles of different shapes and sizes, provided they are not too small.

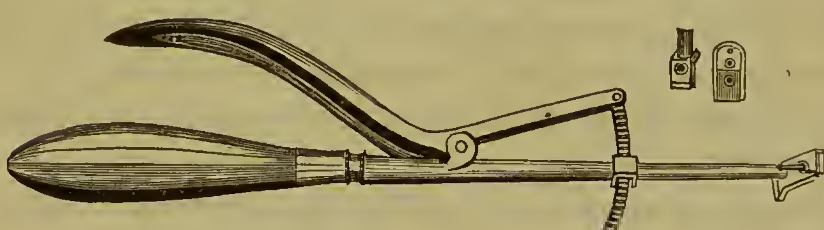
Fig. 85.



The old fashioned bow-and-string drill is now disused; partly because of its formidable appearance, but chiefly because there is danger of revolving it with too great rapidity. Many very ingenious forms of drill-stocks have been, from time to time, invented; of these we present several.

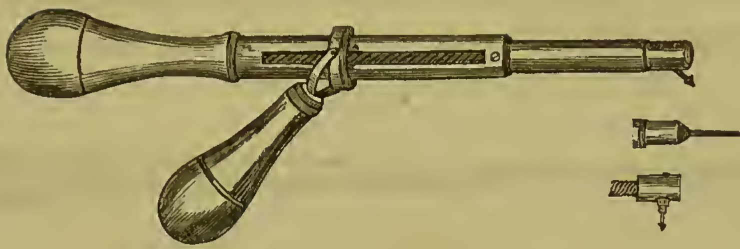
The instrument represented in Fig. 86 is a modification of a very ingeniously contrived drill-stock invented by Dr. Maynard, for opening a cavity in the grinding, buccal or posterior approximal surface of a molar tooth. It is so constructed as to move a drill, pointing in three different directions; but, as in the case of the drill-stock used with a bow, the original instrument required both hands to work it. To obviate which difficulty, it has been so improved that it may be used with one hand, as shown in the above engraving.

Fig. 86.



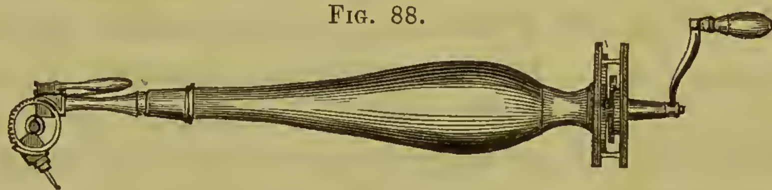
Two drill-stocks were presented to the author some years ago, the first (Fig. 87) by Dr. James Robinson, of London, invented by Mr. McDowell, of Lincoln Inn Fields. It is upon the principle of the helix. A drill-stock, inserted at the end of the screw, is moved by means of a female screw attached to the handle of the instrument. As may be seen from the engraving,

FIG. 87.



drills, pointing in three directions, may be worked in it. The other was presented by Mr. John Lewis, formerly of Burlington, Vt. (Fig. 88.) It is a beautiful and ingeniously contrived in-

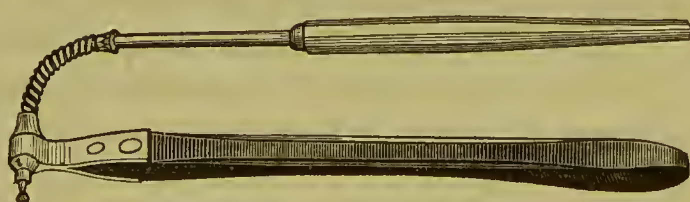
FIG. 88.



strument. The drill may be worked in any direction within its circle of motion, from the line of the handle round to the same line again.

Merry's drill-stock (Fig. 89), more recently invented, is sim-

FIG. 89.



pler than the preceding, and will, doubtless, prove useful in cases where such instruments are necessary.

For opening a cavity in the grinding surface of a tooth, partially covered by projecting portions of the enamel, the rose or burr-headed drill is invaluable, and it can often be advantageously applied to the side of a tooth. There are many cases, too, where the flat triangular-pointed drill can be conveniently employed, as, for example, when it becomes necessary to extend the cavity further into the tooth than the disease has penetrated. When the drill is used, it should be frequently dipped in water to prevent its becoming heated by the friction against the tooth; this precaution ought never to be neglected.

A three-sided instrument brought to a point (Fig. 90), as also a chisel-edged (Fig. 91), and a four-sided one with a cutting

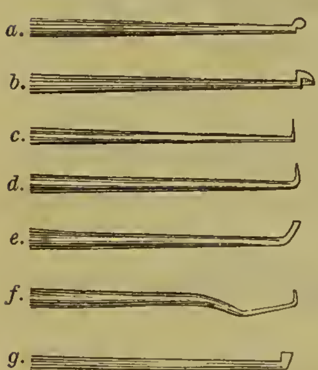
FIG. 90.

FIG. 91.

FIG. 92.

edge (Fig. 92), may often be used advantageously in cutting away portions of enamel to enlarge the orifice. Enamel-chisels of other shapes and gouges are also very valuable instruments for the preliminary operation of opening large cavities, or cutting off sound enamel or dentine whenever necessary. Dr. Forbes, of St. Louis, has devised a series of very useful forms of the enamel gouge which are adapted to the handle in Fig. 85.

FIG. 93.



But the cavity can seldom be completed with either of the instruments mentioned above. After it has been opened, and the orifice made sufficiently large, it should be finished with flat or curve-pointed excavators (Fig. 93), properly adapted to the purpose ; in fact, in the majority of cases, it should be wholly formed with instruments of this sort.

Excavators, shaped like those represented in Fig. 93, have been found by the author to be as well adapted to the removal of caries as any which he has ever employed. There should be several sizes of each shape ; also duplicates of each instrument, to prevent delay, in case of accident while operating. As the proper formation of the cavity greatly depends on having suitable instruments, every operator should be provided with a large supply of burr-drills and excavators, so that he may never be at a loss for such as the peculiarity of any case may require. He should also have the material, and know how, in an emergency, to point his own excavators. For this purpose he will need a lamp, a small anvil and hammer, a set of fine cut files such as are used by watchmakers, and an assortment of steel

rods of various sizes and of the best quality. It is not our purpose to give specific directions for working steel; but we would offer two cautions: first, small points quickly become brittle by hammering and need frequent annealing; second, steel is greatly injured by raising it to a full red or white heat. A very fine temper may be given, after shaping the point, by heating to redness and suddenly plunging it in wax or tallow.

As excavators must be kept very sharp, an oil stone should be constantly at hand. The Arkansas stone is superior for this purpose to all other varieties, on account of its hardness, fineness and sharpness of grit.

MANNER OF FORMING THE CAVITY.

The preparation of the cavity in a tooth for the reception of a filling, is a very essential part of the operation, and though usually the easiest, is sometimes attended with much difficulty. The removal of the diseased part is sometimes all that is necessary, preparatory to the introduction of the gold: but in the majority of cases the cavity must be so shaped, as, when properly filled, to retain the filling in place. The part of the tooth surrounding the orifice should present no rough or brittle edges. The size of the bottom of the cavity should be as near that of the orifice as is possible, even a little larger rather than any smaller. But the difference between the size of the one and the other should never be very great; for if the interior of the cavity is much larger than the orifice, it will be difficult to make the filling sufficiently firm and solid to render it absolutely impermeable to the fluids of the mouth.* If, on the other hand, the orifice is larger than the bottom of the cavity, it will be difficult to obtain sufficient stability for the filling, so as to prevent it from ultimately loosening and coming out. It often happens, however,

* Place a lump of cotton in the hollow of the hand formed by bringing the ends of the fingers against the palm. Then press with an instrument upon the centre of the cotton and it will leave the sides of the cavity. This simple illustration, suggested by Dr. Edward Maynard, will explain the cause of failure, in certain cases which have come under his notice, from the hands of operators of deservedly high reputation.

The cavity, smallest at the orifice, had been well filled; but the final compression upon the centre had drawn the gold from the sides, thus permitting the access of fluids and ultimately decaying the tooth around the filling.

that the situation and extent of the decay is such as to render it impossible to make the cavity so large at the bottom as at the orifice; when this is the case, several pits or circular grooves should be cut in the inner walls, for the purpose of obtaining as much security for the filling as possible; being careful to make these in the dentine, rather than in the enamel, which is so much more brittle. By proper attention to this precaution, a filling may be so inserted, in this difficult class of cases, as to prevent it from coming out.

As a general rule it is easier to form a cavity in the grinding surface of a molar or bicuspid, than in any other position; though it sometimes happens, that even here, it is attended with difficulty, and especially when the decay, commencing in the centre, follows the several depressions which run out from it. In such cases the edges bordering on and covering the affected parts, which are often thick and very hard, should be cut away, together with the subjacent decayed dentine; the radiating depressions should open fully into the central cavity, and be made sufficiently wide and deep to admit of being filled to their extremities in the most perfect and substantial manner. The surface of a filling occupying a cavity of this kind presents a sort of stellated appearance. When two or more decayed places are separated only by very thin walls of tooth substance, these should be cut away and a cavity formed large enough to include all the diseased points; as one large filling will secure the preservation of the tooth more effectually than by filling each cavity separately.

Sharp angles should be avoided, as far as possible, in the outline of the orifice of the cavity, because of the extreme difficulty of filling them compactly. The orifice must also have a firm decided margin; with no thin projecting edges of enamel on the one hand; with no countersunk depressions on the other. In the first case the thin enamel is apt to break off either during the operation or subsequently; in the second case the thin scale on the edge of such fillings breaks away in the course of time; in both cases the filling fails perfectly to answer its purpose in the preservation of the tooth.

Before a cavity can be prepared in the approximal surface of a tooth, it is usually necessary to separate it from the adjoining

one. This may be done either with a file, or by the pressure of some interposed elastic substance. Each of these methods has its advantages. When caries has extended over nearly the whole of the approximal surface, so that after the removal of the diseased part, the orifice of the cavity will be surrounded by a thin, brittle and irregular wall, the former is the preferable method; especially in individuals having a decided scorbutic tendency, or who have suffered from the use of mercurial medicines or syphilitic disease, and in aged persons. But when the caries has spread over only a small portion of the surface of the tooth, and is surrounded by sound, healthy enamel, the latter method should be adopted; especially in individuals in whom there is no manifest tendency to inflammation or sponginess of the gums, and in young subjects. The manner of separating teeth with a file, has been already described; it will only be necessary, therefore, in this place, to offer a few remarks on separating by pressure, which was first adopted by Dr. Eleazar Parmly.

The following are its advantages, where it can be resorted to with safety: after the removal of the pressure, the teeth almost immediately come together, leaving no space to injure their beauty; what is of still greater importance, the dentine around the external surface of the filling is not exposed to the action of the secretions of the mouth, or other agents capable of exerting upon it a deleterious action. On the other hand, some are of opinion, that when the teeth come together again a lodgment is afforded to corrosive agents, upon the presence of which the disease was, in the first instance, produced, and which would soon cause a recurrence of it. In replying to this objection, it is only necessary to observe, that the parts of teeth first attacked by caries, were the points in contact with each other, where the enamel may be supposed to have sustained some injury by pressure, thus rendering them more vulnerable at these points to the action of the causes that produced the disease. By properly replacing the diseased parts with gold, the external surfaces of the fillings will be the only parts that come in contact with each other; and if of gold, will not be liable to injury from the above mentioned mechanical causes. The enamel around the fillings, if proper attention to cleanliness be observed, is not so liable to

be acted on by chemical agents as the dentine which the file would expose.

But teeth cannot always with impunity be separated by pressure; it can only be done with safety in certain cases. As a general rule, the writer is of the opinion that it ought not to be attempted after the thirtieth or fortieth year of age, though it may sometimes be done with safety at even a later period. The diseased action, excited for the time, in the sockets of the teeth, does not so readily subside, at a later age; and it has in some instances, been known to result in the loosening and ultimate loss of the organs. In one case which came under the observation of the author, the inflammation extended to the lining membranes of the pulp, causing their disorganization, and the consequent death of the tooth.

The pressure ought never to be too actively exerted; it should be gradual and constant. From four to twelve days are usually required for the separation of two teeth sufficiently for the removal of the decayed part and the introduction of a filling. After they have been separated in this way, they should be kept apart, without any increase of pressure, until the soreness in the sockets shall have subsided, before any farther steps are taken in the operation. Only two teeth should be separated in the front part of the mouth, in the same jaw, at the same time.

The pressure is usually made by introducing, between the crowns of two teeth, a thin wedge of soft wood, a piece of gum-elastic, tape, or a little raw cotton, replacing it every day or two with a thicker piece. The writer prefers gum-elastic to any other substance he has employed for the purpose; but the object may be readily attained with other substances.

But whether the teeth be separated with a file or by pressure, the space should be sufficiently wide to enable the dentist to operate with ease; otherwise, it will be impossible to remove the caries and fill the teeth in a proper manner.

Dr. Maynard prefers in many cases of front approximal fillings to cut away the inner angles of the tooth, thus avoiding the injury to the external appearance of the tooth caused by the file. Upon completion of the operation the surface thus cut is perfectly polished, and so shaped as to be kept readily cleansed with the brush or with floss silk.

After every particle of decomposed dentine has been removed, the cavity should be thoroughly cleansed before the filling is introduced. This may be done by first injecting tepid water into it with a properly constructed syringe, and afterward wiping it dry with a small lock of raw cotton fixed upon the point of a probe or excavator; or, the cavity may, in the first place, be wiped with a little raw cotton moistened with water, and afterward with dry cotton. Some recommend tissue paper for drying the cavity, for the reason that it absorbs moisture more readily than cotton. The latter, however, is the most convenient, and is equally as good as the former. Its absorbing qualities may be increased by boiling it for fifteen or twenty minutes in a tolerably strong alkaline solution; this done, it should be thoroughly washed and dried before using. Several materials have been of late years used in drying cavities. Bibulous paper, made expressly for the purpose, and having a very loose absorbent texture. Prepared flax, fine and white, with a long absorbent fibre. Cotton from which the natural oil has been removed by saturation in ether. It is desirable that the cavity should be perfectly dry before the filling is introduced.

INSTRUMENTS FOR INTRODUCING GOLD FOIL.

For introducing and consolidating the gold, a number of instruments are required, which should be sufficiently strong to resist any amount of pressure the dentist can safely exert in the operation. They should have round or octagonal handles, large enough to prevent the liability of being broken, and to enable him to grasp them firmly. Their points should vary in size, though none should be very large. Several should be straight, but for the most part, they require to be curved—some very slightly, others forming with the shaft of the instrument an angle of ninety degrees.

Plugging instruments as received from the instrument makers have usually a temper which will not permit them to be bent. It will add we think greatly to the value of the instrument, if the practice of Dr. Maynard were more generally adopted. He gives to the extreme point a hard temper (straw color) to prevent it from wearing; for a little distance, say one to three quarters of

an inch, a spring temper is given (purple or blue color) to insure strength when the shape is delicate; the rest of the instrument is left soft, so as to admit of being bent (with pliers) in the direction best suited for that particular point in any given operation.

Most of them should have a slim wedge-shape: some, however, both of the straight and curved instruments, should have blunt serrated points, and a few should have highly polished oval points, for finishing the surface of fillings. Formerly most dentists employed for introducing and consolidating the gold, simple blunt-pointed pluggers; but it is impossible with such instruments to make a filling as firm and solid as it should be for the perfect preservation of a tooth, especially if the cavity is large. From one-fourth to one-half more gold can be introduced into a tolerably large cavity, with a wedge-pointed than with a blunt-pointed instrument.

The sides of the wedge-pointed pluggers should be left a little rough, for the purpose of preventing them from cutting the gold, and there should be two or three small notches filed across their edges. When thus prepared, the gold can be more perfectly controlled and more readily conveyed to the bottom of the cavity than with smoother-edged instruments. The blunt-pointed instruments, or those used for condensing the extruding extremities of the folds of gold, should, as before stated, have serrated points, that the surface of the metal may be thoroughly consolidated.

This general description will serve to convey a tolerably correct idea of the kind of instruments required for the operation; but no two dentists have their filling instruments precisely alike; each has them constructed in such a way as he thinks will enable him to apply them most easily and efficiently to the various parts of a tooth which may require filling. In the chapter on filling individual cavities in teeth, cuts of most of the instruments employed in the operation will be found.

Points of somewhat different construction are required for filling teeth with crystalline or sponge gold, and with adhesive foil; these will be described in their respective places.

MANNER OF INTRODUCING AND CONSOLIDATING GOLD FOIL AND FINISHING THE SURFACE OF THE FILLING.

The operator, being provided with the necessary instruments, should cut his gold with a pair of scissors, into strips from half an inch to an inch wide. Each of these should be loosely rolled or folded together lengthwise, and after the cavity has been properly cleansed and dried, the end of one should be introduced and carried to the bottom of the cavity, with a straight or curved wedge-pointed instrument; the roll on the outside should then be folded on the part first inserted. The folding should be commenced on one side of the cavity, and the inner end of each fold taken to the bottom, the outer extending nearly a twelfth or an eighth of an inch on the outside of the orifice; thus, fold after fold is introduced, until no more can, in this manner, be forced into the cavity. Having proceeded thus far with the operation, the instrument should be forced through the centre of the filling, and the gold firmly pressed against the walls of the cavity. The opening thus made should be filled in the manner as first described, and this time it should be packed in as tightly as possible. This done, the operator should endeavor to force in a small wedge-pointed instrument, at the side, or, what is much safer, the centre of the cavity, until he has tried every part of the plug; filling, as he proceeds, every opening which he makes, and exerting, in the packing of the gold, all the pressure which he can apply, without endangering the tooth. If one roll or fold of gold is not enough, he should take another and another, until the cavity is thoroughly filled.

The advantage to be derived from introducing the gold in this manner is obvious. By extending the folds from the orifice to the bottom of the cavity, the liability of the gold to crumble and come out, is effectually prevented; while, by introducing it with a wedge-pointed instrument, it may be carried into all the depressions of the walls of the cavity, and rendered altogether more solid than it could otherwise be made. The pliancy and adhesiveness of the gold may be increased by slightly annealing in the flame of a spirit lamp, after it has been made into rolls or folds.

After the cavity has been completely filled, every portion of the projecting part of the gold must be thoroughly consolidated, either with a small blunt-pointed instrument, straight or curved as may be most convenient; or if the filling is in the approximal side of a tooth, it may be compressed with the angle of the point of the plugger, making the adjoining organ to a slight extent a kind of fulcrum for the instrument. After the filling has been thus consolidated, as long as it can be made to yield in the least to the pressure of the instrument, the protruding parts may be scraped or filed off, down to the tooth, so as to form a smooth, uniform, gently swelling or perfectly flat surface. If in this part of the operation any portion of the gold should crumble or be dislodged, which it will not do if it has been properly introduced and consolidated, the injury may be repaired by making in the part of the plug, where it has occurred, an opening, and filling it, or by the removal of the whole of the filling and the introduction of another. Every part of the surface of the filling should be uniform and free from the slightest indentations which may afford lodgment to clammy mucus or extraneous matter of any sort. This is a point which should never be lost sight of, for, however excellent the filling may be in other respects, if the surface is not smooth, uniform, and flush with the orifice of the cavity, the object intended to be accomplished by it will be partially if not wholly defeated. If any portions of the gold have been forced over the edge of the orifice of the cavity, they should be carefully removed, either with a file or sharp-pointed cutting instrument suited to the purpose. This precaution should never be neglected, especially when the filling is in the approximal surface of a tooth, where a portion of the gold is very liable to be forced up or down upon the neck, and under the gum.

After having prepared the surface of the filling in the manner as here described, it may be rubbed with finely powdered pumice stone, or with a small stick or slab of Arkansas oil-stone, until all the file scratches or other asperities are removed. If the filling is in the grinding, buccal or palatine surface of a molar or bicuspid, a long piece of the stone, having a small triangular and slightly oval point, may be used; if powdered pumice stone be employed, it may be used on the point of a similarly shaped piece of soft wood, previously moistened in water. For a filling in the approximal surface of a tooth, the oil-stone may be shaped

like a pinion file; it should be frequently dipped in water, and when its pores become filled with gold, the surface may be ground off by rubbing it on a corundum slab. If the filling is finished with pumice, it may be applied with floss silk or tape moistened with water, by drawing it backward and forward across the surface of the filling.

After all the asperities have been cut down, the surface should be washed until every particle of grit is removed. This done, it may be polished with a suitable burnisher, dipping it in water from time to time, having a small quantity of pure castile soap dissolved in it, until the filling is rendered as brilliant as a mirror. Having proceeded thus far, it may be again washed, and the operation completed by rubbing it from three to six minutes with dry floss silk.

When the caries has penetrated nearly to the pulp cavity, the presence of a gold or any other metallic filling is sometimes productive of considerable pain and irritation, especially when hot or cold fluids are taken into the mouth, or during the inspiration of cold air. In some cases, inflammation and suppuration of the lining membrane and pulp supervenes. To prevent these disagreeable results, a variety of means have been proposed. Dr. Solyman Brown recommends placing asbestos, this being a non-conductor of caloric, on the bottom of the cavity, previously to the introduction of the gold. Others recommend placing a thin piece of cork, and others, again, oiled silk, between the filling and the bottom of the cavity. The author prefers a thin layer of *gutta percha.* This is less destructible than either of the two last named articles, and can be more conveniently and perfectly applied. It may be used in the form of a thick solution, prepared with chloroform, or a layer of thin gutta percha cloth may be placed at once in the bottom of the cavity. When the solution is used, a drop may be placed in the cavity, and a sufficient time allowed for the choloroform to evaporate, before introducing the filling. A thin layer of "Hill's stopping," of which gutta percha forms the principal ingredient, may be used with equal advantage.

The time required by an expert operator to fill a tooth well, may be said to vary from thirty minutes to two hours and a half, according to the size, shape, and situation of the cavity, and in some cases a much longer time will be required. The author

has found it necessary in filling some cavities, especially when the restoration of a large portion of the crown was called for, to bestow as many as six hours' constant labor upon the operation. Less time and skill are usually required to fill a cavity in the grinding than in the approximal surface of a tooth; but the operation in either place, to be beneficial to the patient, must be performed in the most thorough manner. The dentist who does not feel the importance of making all his operations as perfect as possible, should never be entrusted with the management of these important organs. Want of attention to two points in the consolidation of a filling, often causes the ultimate failure of operations in all other respects well performed. First, by not making sufficient *lateral* compression whilst introducing the gold, the surface is apt to be more solid than the interior. Consequently the filling may drop out for want of a firm contact against the sides; or if retained, it is apt on grinding surfaces to be pressed inward, leaving a space around the orifice for the penetration of fluids. Second, want of care in condensing around the edges of the filling, will, by the crumbling away or scaling off of portions of the gold, expose the edges of the cavity to decay.

In every part of the operation, the dentist should so guard his instruments as to prevent them from slipping; which he will usually be better able to do by standing a little to the right and behind his patient than in any other position. In filling the lower teeth he should stand several inches higher than while filling the upper, and for this purpose he should have a stool, or movable platform on which to stand. When it can be done, he should grasp the tooth with the thumb and fore-finger of his left hand, not only to prevent it from being moved by the pressure he applies, but also to catch the point of the instrument in case it should slip; if he is always careful to press in a direction towards the orifice of the cavity, this need not happen; nevertheless, he should always take the precaution to guard against possible accident. When he cannot shield the mouth with the thumb and finger of his left hand, he should let the thumb or one of the fingers of his right rest either upon the tooth he is operating on, or upon some other.

For the special application and modification of these general directions to the filling of individual cavities in teeth, the reader is referred to the next chapter.

CHAPTER FOURTH.

FILLING INDIVIDUAL CAVITIES IN TEETH.

To describe the method of filling each individual cavity in every locality in which a tooth is liable to be attacked by caries, would be unnecessarily tedious. But, as this is one of the most important, and, at the same time, one of the most difficult operations in dental surgery, it may be well to enter a little more into detail upon the subject, than we have as yet done. In doing this, the writer will confine himself, for the most part, to the manner of filling a cavity in each of the following localities, which are the parts of teeth most liable to caries.

First.—In the approximal and labial surfaces of the superior incisors and cuspids, and the palatine surfaces of the incisors—the anterior surfaces of the cuspids and the posterior surfaces of cuspids and incisors being rarely attacked by caries.

Second.—In the grinding, approximal, buccal and palatine surfaces of the molars and bicuspids of the upper jaw.

Third.—In the approximal surfaces of the inferior incisors and cuspids.

Fourth.—In the grinding, approximal, and buccal surfaces of the molars and bicuspids of the lower jaw.

Other parts of the teeth sometimes become the seat of caries, but the foregoing are the localities most liable to be attacked by the disease.

FILLING THE SUPERIOR INCISORS AND CUSPIDS.

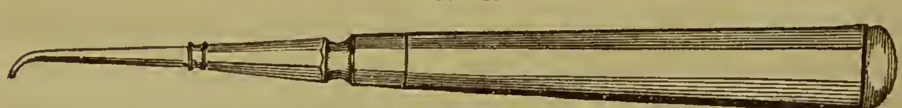
In describing the manner of introducing a filling in one of the first named teeth, we shall commence with the right approximal surface of the left central incisor. The directions we propose giving for the performance of the operation here, will be applicable with a few exceptions to the same surface, on all the upper incisors. As a general rule the gold should be introduced from

behind the teeth forward and upward, and for the following reasons: 1. When the aperture between the teeth has been formed with a file, it should, when the circumstances of the case will permit, and for reasons stated in another place, be made wider behind than before; consequently, the diseased part can be most easily approached from this direction. 2. The gold, in the majority of cases, can be more conveniently introduced from the palatine side, and the force required for condensing it can be more advantageously applied.

The exceptions to the above rule are, when the approximal side of the tooth is turned slightly forward toward the lip, and when the caries is situated nearer the labial than the palatine angle; also, when the teeth, instead of occupying a vertical position in the alveolar border, or projecting slightly as they usually do, incline backward toward the roof of the mouth. It sometimes happens, too, when they are separated by pressure, that the diseased part can be most conveniently reached from before.

The instrument which the writer has found best adapted for the introduction of the gold into a cavity in the right approximal surface of an incisor or cuspid tooth, is represented in Fig. 94. The width and length, as well as the curvature or angle of the point, should vary according to the size of the cavity and the width of the space between the teeth.

Fig. 94.



The stem of the instrument as well as the shank should be strong enough to sustain any amount of pressure which it may be necessary to apply in forcing the folds of gold tightly against each other. The point should be wedge-shaped, and the extremity serrated.

The ornamental beading and collar are objected to by some operators, as apt to wound the mouth. The shaft, ferule and handle may be made continuously tapering, as in Fig. 95.

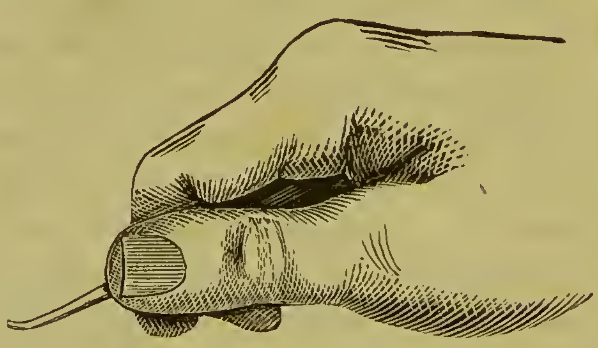
Fig. 95.

The decay having been removed, the cavity, properly shaped, cleansed and dried, is ready for the reception of the gold. The patient should be seated in a chair sufficiently high to bring the head on a level with the breast of the operator, and resting on the head-piece of the chair with the face upward. The operator standing upon the right side, should support the patient's head firmly with his left arm during the operation, while with the thumb and fore-finger of the same hand, the strip or roll of gold is held, and one end placed in a proper position to be introduced into the cavity. The middle finger of the same hand ought to rest on the end of a tooth to the left of the one on which the operation is being performed, while with the little finger the lower lip may be gently depressed.

During the introduction of the gold, the instrument should be held (Fig. 96,) in the right hand of the operator, and grasped with sufficient firmness to prevent it from slipping or rotating.

In introducing the gold, the first fold should be applied against the upper wall of the cavity, that the pressure may always be exerted in a direction toward the extremity of the root, applying each additional fold as closely to the preceding one as possible. The folds should, also, in their introduction, be applied as closely to the labial and palatine walls of the cavity as possible, but always directing the pressure, when these are thin and brittle, in the direction of the axis of the root.

Fig. 96.



When the lower part of the cavity is very narrow, as is often the case, especially where it extends nearly to the labial angle of the tooth, it is often necessary to change the instrument for one having a smaller point.

To carry a fold of gold to the bottom of a cavity, upon the point of the instrument, without breaking or cutting it, requires some tact. The point should never be carried directly toward the bottom: on entering the orifice, it should be inclined toward

the wall of the cavity opposite the one against which the folds are first laid. Equally as much tact is required to prevent displacing the gold before a sufficient quantity has been introduced to procure support for it from the surrounding walls: which is an accident particularly apt to occur with young practitioners, when the cavity is superficial and has a large orifice. To prevent this, the folds of gold should be long enough to project some distance from the orifice, that they may receive support from the adjoining tooth, and from the thumb and fore-finger of the left hand of the operator, until the operation has reached that stage when sufficient stability shall have been obtained from the walls of the cavity.

There are cases in which an instrument like the one represented in Fig. 97 can be very advantageously employed in the introduction of the gold; but in the majority of cases the instrument represented in Fig. 94 will be found more convenient.

Fig. 97.

After having filled the cavity so thoroughly that a small wedge-pointed instrument cannot be made to penetrate the gold at any point, the extruding portion of the filling should be consolidated; beginning with the portions overlapping the lower part of the tooth and the edge of the posterior wall. These should be carefully and firmly pressed toward the cavity, with an instrument like the one represented in Fig. 98. This done, it may be firmly applied to every part of the surface of the filling, continuing the pressure as long as the point of the instrument can be made to indent the gold.

When the space between the teeth is very narrow, an instrument shaped as in Fig. 99 may be used. The operator should be provided with two or three instruments like each of the two last, varying in the size, length and curvature of their points.

Fig. 98.

Fig. 99.

During the process of consolidating the gold, the teeth should be firmly grasped between the thumb and fore-finger of the left hand; this prevents it from being pressed too forcibly against

the opposite side of the socket, while, at the same time, the end of the fore-finger, by being placed above the instrument, assists in directing its point, and serves to keep it from slipping. When the labial and palatine walls of the cavity are very thin, great care is necessary to prevent fracturing them, in introducing and consolidating the gold. The consolidation should be commenced around the edges, and the pressure applied toward the centre of the cavity.

It sometimes happens that the caries extends forward to the labial angle of the tooth, and upward, at the same time, under the edge of the gum. Great difficulty is often felt in thoroughly filling this portion of the cavity, and it cannot always be done from behind the tooth. In this case, after having filled the cavity in the manner as already described, the operator may, standing on the left side of the patient, and with an instrument having a wedge-shaped point, (Fig. 100,) make as large an opening as possible in the gold. This done, he may grasp the left lateral incisor, or cuspid tooth, with the thumb and middle finger of his left hand, elevating the upper lip with the fore-finger of the same; then, with the instrument held as in Fig. 101, he may proceed to introduce the gold, filling

Fig. 100.

Fig. 101.

the upper part of the opening first. After introducing fold after fold, until it is completely and compactly filled, the extruding portion should be consolidated with a similarly shaped instrument, having a round serrated point, or the one represented in Fig. 99.

The size of the roll of gold must be varied to suit the size of

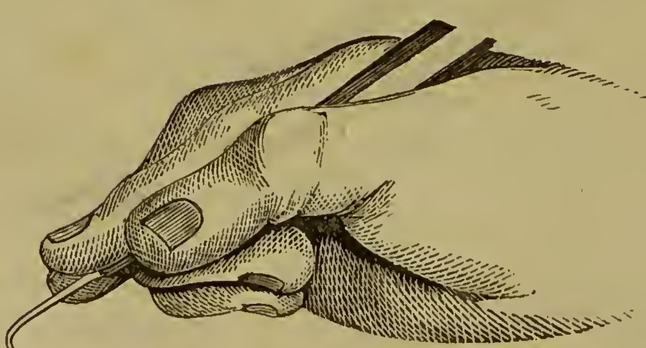
the cavity, though it should seldom have in it more than a fourth of a leaf of No 4. If more than this be employed at one time, it will be difficult to apply the folds sufficiently near each other.

When the teeth have been separated by pressure, or when the aperture is as wide anteriorly as posteriorly, the gold may be introduced from either side as is most convenient; but, when introduced from before, it may be done in the manner as just described, the operator standing on the left side of his patient, and using such instrument as he finds best adapted (Fig. 94 or 100). The gold having been introduced and condensed, the surface of the filling is to be finished in the manner already described.

The method of filling the right central incisor in the left approximal surface is so very similar to that of filling the left in the right side, that it will not be necessary to enter so minutely into detail. In this as in the other case, the gold, as a general rule, should be introduced from behind the tooth, forward and upward; but if introduced from the front, the operator should still stand on the right side of the patient. The head should have the same elevation, and inclination backward; but the face should be turned more toward the operator to give him a better view of the cavity in the tooth, and to enable him to reach it more readily with the instrument.

The cavity being formed, cleansed and dried, the operator may proceed to introduce the gold as already directed, with an instrument like the one represented in Fig. 94. In many cases,

Fig. 102.



however, he will require one having a somewhat longer point, and curved at nearly a right-angle with the stem. The instrument should be held somewhat differently in the hand (Fig. 102),

and grasped firmly with the thumb and fore and middle fingers, so as to prevent it from rotating. The head should be securely confined with the left arm, the upper lip raised with the left thumb, pressing it at the same time firmly against the anterior surface of the tooth. The middle or fore-finger of the same hand may be placed against the gum just inside the tooth, to direct the application of the point of the instrument, prevent the liability of its slipping, and control the free end of the roll of foil. The lower lip may be depressed either with the middle joint of this, or with one of the other fingers.

After having placed one end of the gold in the cavity, fold after fold should be introduced until it is compactly filled; except in those cases where the lower part is very small, when a smaller pointed instrument should be employed for the completion of the operation; and indeed for the introduction of all the gold, if the cavity is not large or the aperture between the teeth very narrow.

For consolidating the extruding gold, the instrument represented in Fig. 98 will, in many cases, be all that is required. But the one represented in Fig. 103 can sometimes be used very

FIG. 103.

FIG. 104.

advantageously; and the one in Fig. 104 will be found a useful condenser for the right, as well as the left, approximal surface of an incisor, or cuspid tooth; and both the last mentioned instruments may often be used to great advantage on the approximal surfaces of other teeth. The instruments represented in the chapter on filling teeth with crystalline and sponge gold (Fig. 129), may also be advantageously employed in consolidating the ordinary gold in the approximal surfaces of the incisors and other teeth.

In completing the operation, it is important that every particle of gold overlapping the orifice, and frequently extending under the free edge of the gum, should be removed before finishing the surface of the filling; but the operator ought, at the same time, to avoid as much as possible wounding the gum and dental periosteum. As the cavity frequently extends a little

above the gum, great care is necessary to prevent wounding it; indeed, there are many cases in which it cannot be avoided, unless the point of the gum is pressed up between the teeth, by the introduction of a piece of raw cotton, or gum elastic, a day or two before the operation of filling is performed.

In filling an incisor, or cuspid tooth, on the labial surface, the operation is often very simple and easy; but there are many cases in which it is both difficult and tedious. The head of the patient should rest with the face upward, as already described, and sustained in the same way with the left arm of the operator; while, with the thumb of the left hand placed on the gum above the tooth, the upper lip should be elevated.

The fore-finger should be pressed firmly against the palatine surface of the tooth, and the left side of the chin gently grasped with the other three fingers. Then, with an instrument (Fig. 105) having a wedge-shaped point, grasped with the right hand, as in Fig. 102, or 106, the operator should proceed to introduce the gold, standing at the right side of the patient, with the thumb of the right hand resting on a tooth to the left of the one he is about to fill, or against the cheek. He should commence by laying the first folds against the walls of the cavity nearest to him, and thus introduce fold after fold, until it is compactly filled. The ex-

Fig. 105.

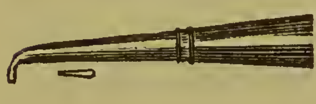


Fig. 106.

truding portion may be consolidated with a round or square-pointed instrument, or with a straight-pointed one as represented in Fig. 107. Great care is necessary to prevent the instrument from slipping and wounding the gums. After having partially

consolidated the gold, the overlapping portion must be firmly pressed toward the centre of the cavity, and the point of the instrument repeatedly applied to every part of the surface of the filling, until it can no longer be made to yield to pressure. This done, the gold may be filed down to the level of the tooth, smoothed with Arkansas stone, and burnished or polished.

Fig. 107.

When the cavity is shallow and the orifice broad, the gold as it is introduced must be held in its place with the thumb of the left hand, until a sufficient quantity has been placed in the cavity to obtain for it the necessary support from the surrounding walls. But in overcoming difficulties of this sort, the peculiar circumstances of the case can alone suggest the proper means to be employed by the operator.

The decay sometimes extends entirely across the labial surface of the tooth, leaving, after its removal, a horizontal groove open at both ends. In this case the walls should be made rough, wider at the bottom than at the opening, and the operation of filling commenced at one end, by applying the folds of foil, alternately against the upper and lower wall, and consolidating them so thoroughly as to prevent the liability of their being displaced during any subsequent part of the operation. Successive folds are introduced in the same manner, each in close contact with the preceding series, until the groove is completely filled, applying the pressure during the whole of the operation against the two walls. In condensing the extruding gold, the operator should commence, first at one end of the groove, then at the other, and afterwards consolidate the whole surface of the filling. In finishing the operation, the same precaution, with regard to wounding the gum and dental periosteum, should be observed here as recommended for the approximal surface of the tooth.

Although it rarely happens that the palatine surfaces of the upper incisors are attacked by caries, yet the disease does sometimes develop itself there, in the indentations occasionally found a little below the free edge of the gum. The removal of the diseased part, the formation of a cavity, and the introduction of a filling, can, in the majority of cases, be more easily accomplished in this, than in any other part of an incisor tooth.

The cavity being properly prepared for filling, the head should be placed as before directed, except that the chin may be a little more elevated, to enable the operator to obtain a more convenient view of the locality of his operation; the thumb of the left hand may be placed on the labial surface of the tooth; and the fore-finger on the gum immediately above the palatine surface. He should now, with a wedge-pointed instrument, shaped as in Fig. 108, proceed to introduce the gold, applying

FIG. 108.

FIG. 109.

the first fold against the palatine wall or the palato-approximal angle of the cavity, as may be most convenient. Having filled the cavity, the extruding gold may be condensed with an instrument like the one represented in Fig. 109.

Sometimes straight instruments, and at other times instruments curved at the points more than those represented in Figs. 108 and 109, can be more conveniently employed; depending altogether upon the size of the mouth and the forward or backward deviation of the teeth from a vertical position. This is a matter, therefore, which the judgment of the operator must determine.

FILLING THE SUPERIOR MOLARS AND BICUSPIDS.

In describing the manner of filling a cavity in each of the principal localities liable to be attacked by caries, in the above mentioned teeth, the writer will begin with the grinding surface of the first molar on the right side. The directions given for filling a cavity here, will, with a few exceptions, be applicable to the introduction of a filling in the grinding surface of any of the upper molars or bicuspids.

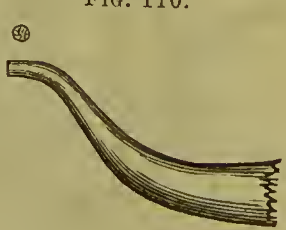
When the cavity is very deep, and its circumference not large, it is difficult, if not impossible, to make a filling sufficiently firm and solid in every part by the introduction of folds of gold long enough to extend from the bottom to the orifice. The operation, therefore, should be divided into two parts: two-thirds of the cavity should be first thoroughly filled with vertical folds, and afterward the remaining third in the same manner.

In filling a molar or bicuspid on any of its surfaces, the head of the patient should, for the most part, occupy very nearly the same position, and have the same elevation as required for an operation on an incisor or cuspid. The cavity being prepared for the filling, and one end of the roll of foil placed in it, the tooth may be grasped with the thumb and fore-finger of the left hand of the operator—the former placed on the buccal surface in such a manner as to press back the commissure of the lips, and the latter on the palatine surface; then fold after fold may be introduced and forcibly pressed against the posterior wall until the cavity is filled. For this purpose an instrument may be used like the one represented in Figs. 105 or 107. If the former is used, it is to be held as shown in Fig. 102. The extruding portion should then be condensed with a straight instrument as in Fig. 107, or curved pluggers, Figs. 109 or 110, as may be most convenient.

As a general rule, filling a cavity in the grinding surface of an upper molar or bicuspid is an exceedingly simple operation, requiring less skill than the introduction of a plug in any other locality in these teeth; but there are cases in which it is rendered very difficult; as for example, when there are one or more fissures or carious depressions radiating from the main cavity. After the caries has been removed, which is often a very tedious operation, it requires considerable time and skill to fill these thoroughly. When it is not properly done, as is too often the case, a recurrence of the disease will soon take place, and thus defeat the object for which the operation was performed.

The introduction of a filling in the grinding surface of the second or third molar of a person having a very small mouth, is sometimes attended with great difficulty; in some cases it can only be done with an instrument having a point bent nearly at right angles with the stem, like the one represented in Fig. 110; consequently the power required for introducing and consolidating the gold is applied to great disadvantage. But the instrument represented in this cut is only intended for the first part of the operation of consolidating the metal: for its completion, smaller points are required.

Fig. 110.

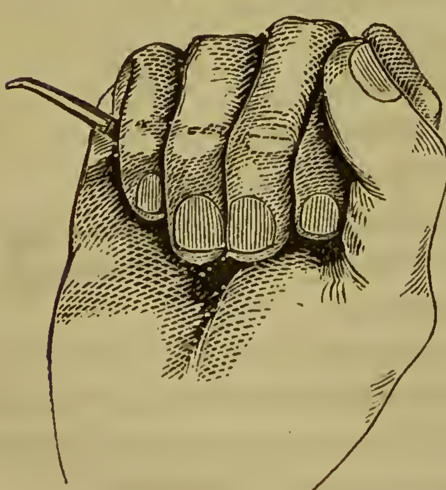


In filling a cavity in the grinding surface of a first upper molar on the left side of the mouth, the thumb of the left hand may be placed against the left cuspid or first or second bicuspid as may be most convenient to the operator; while the forefinger is placed behind the point of the instrument, and at the same time made to push back the commissure of the lips. To obtain a good view of the cavity in a second or third molar during the operation, the cheek should be pressed from the tooth with the forefinger of the left hand; but this finger can seldom be carried far enough back on this side of the mouth to be placed behind the point of the instrument. During the introduction of gold, the ring finger and little finger of the right hand should be made to rest on the incisor teeth, while the instrument is grasped (Fig. 102) with the thumb, middle, and forefinger.

In filling a cavity in the anterior approximal surface of a right superior molar or bicuspid, the operation may be commenced by placing the gold against the palatine wall, and ending at the buccal. But before the process of condensing is commenced, every portion of the surface ought to be thoroughly tested with a wedge-pointed instrument, and wherever the point can be forced into the gold, the cavity thus formed should be filled. The instrument employed for the introduction of the gold may be like the one represented in Fig. 105, but having a rather longer point; and grasped as in Fig. 102. For condensing the extruding portions, either or both of the instruments represented in Figs. 97 and 103 may be used, as also the one employed for the introduction of the gold; and one shaped as in Fig. 111 may be sometimes used with great advantage. During this part of the operation, the instrument may be held as before, or as seen in Fig. 112, which permits a much greater amount of force to be applied than when held in any other manner.

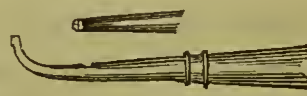
Fig. 111.

Fig. 112.



Nearly the same method and the same instruments are required for filling a corresponding cavity on the opposite side of the jaw. When practicable, the forefinger of the left hand should be plaeed on the palatine surfaee of the tooth, and the thumb against the buccal surface, and in addition to the instruments recommended for the right side of the mouth, the one shown in Fig. 97 may be very conveniently employed to introduce the gold; also one like Fig. 99, or Fig. 113, in condensing the surface of the filling. The writer finds this last particularly valuable in very many cases.

Fig. 113.



A cavity in the posterior approximal surface of a superior bicuspid on either side of the mouth, can, in the majority of eases, be as easily filled as one in the anterior approximal surface. The position of the left hand is very nearly the same, and in the introduction of the gold, the first folds are placed against the palatine wall of the cavity. By commeneing on this side, the operator is enabled to lay the folds more eompaetly than he could, were he to commenee at any other point. He also has a more perfeet control over the instrument in this part of the operation, and has a better view of the cavity during the introduetion of the gold. For consolidating the filling, the instruments represented in Figs. 98, 99, and 104 are as well adapted to the purpose as any that can be employed.

When the mouth of a patient is large, a filling can often be introdueed with nearly as mueh ease in the posterior approximal surfaee of a first, or even a second upper molar, as in that of a bieuspid; but when the mouth is small and the cheeks fleshy, it often beeomes a diffieult and perplexing operation. Although the same method is used; yet, as it is absolutely necessary to the introduetion of a good filling, that the operator should see the cavity and witness every part of the operation, his ingenuity is often taxed to the utmost in contriving the most suitable means to enable him to do it. A number of instruments for drawing baek the eorner of the mouth have been invented; but the writer believes there are none so well suited to the purpose as the thumb or forefinger of the left hand of the operator. If

the operator will accustom himself to the use of a small mouth glass held in the left hand whilst operating, he will be spared many back-breaking efforts to keep in view fillings on posterior surfaces. It is necessary to become familiar with the apparently reverse motion of the instrument as seen in the glass; also to accustom the three fingers of the left hand to act independently of the thumb and forefinger. But one of the most careful and skillful operators of this or any other country, Dr. Maynard, assures us that he works from a reflected view in the glass with the same ease as where he has a direct view of the cavity, and obtains, in very many cases where he uses the glass, an accuracy of view which direct vision could not give him.

Before dismissing this part of the subject, there is one point to which the attention of the young practitioner should be particularly directed. Many, in other respects tolerably good operators, are most likely to fail in not introducing a sufficient quantity of gold in the upper palatine portion of the cavity. The author frequently meets with cases in which the walls of the cavity are perfectly sound, and every other part of the filling well consolidated, but here upon the application of a wedge-pointed instrument the gold is easily perforated. He would, therefore, advise the inexperienced operator to test this by severe pressure with a sharp wedge-pointed instrument, as well, indeed, as every part of the filling, before leaving the operation. There is also one other precaution applicable to fillings in the approximal surfaces of the incisors and cuspids as well as of the molars and bicuspids; it relates to overlapping portions of gold under the free edge of the gum, which must be carefully and completely removed before the operation can be regarded as complete.

In filling a cavity in the buccal surface of an upper bicuspid or molar, on either side of the mouth, the gold may be introduced with the instruments represented in Figs. 95, 105. The latter is better adapted for the left side, but may also be used on the right. The straight wedge-pointed instrument may also be advantageously employed on this side. The first folds of gold should be placed against the posterior wall, proceeding from behind forward, and pressing the folds against each other as compactly as possible. When the cavity has a large orifice, and

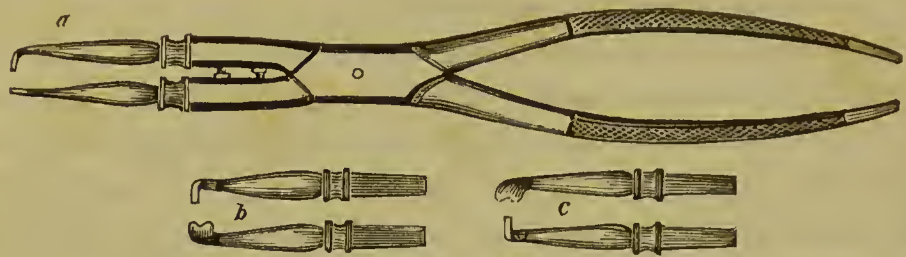
is rather shallow, or in other respects badly shaped for the retention of the gold, the operation is often tedious, difficult, and perplexing. But under favorable circumstances a filling may be almost as readily introduced here as in any other part.

The palatine surface of a bicuspid or of a molar is rarely attacked by caries; on the latter it is usually seated in a depression at the termination of a fissure leading from the posterior depression in the grinding surface. It is usually situated near the posterior palato-approximal angle of the crown about half way between the gum and the coronal extremity of the tooth. It sometimes happens that the walls of these fissures are affected with caries throughout their whole extent, requiring to be filled from the depression in the grinding to its termination on the palatine surface. In this case, the portion of the cavity on the grinding surface may be first filled; then the operator may proceed to fill the palatine portion in the same manner as if it were a simple cavity, placing the first folds of foil, in the case of a right molar, against the upper and posterior side of the opening with an instrument like the one represented in Fig. 105. Great care is necessary to prevent the instrument from slipping. It often happens, too, that the orifice becomes choked with foil before the cavity is half filled. This, indeed, is liable to occur in filling any cavity in any tooth; and when it does happen, unless a sufficient amount of pressure is applied to make a free opening into it, the filling will be imperfect and the object of the operation wholly defeated. When the cavity is situated in a left molar, the gold may be introduced with the instruments represented in Figs. 95, 108, placing the first folds against the upper wall of the cavity, and proceeding downward.

The curvatures of the points of condensing instruments may be similar to those employed for the introduction of the gold. The process of condensing the extruding portion of a filling in the buccal or palatine surface of a molar, as well as in the approximal surface of almost any isolated tooth, may be greatly aided by properly constructed forceps. The following cut will convey a more correct idea of their construction than any description that can be given. They are provided with both straight and curved points, see Fig. 114, *a*, *b*, *c*, and are used by placing the flat jaw, covered with raw cotton or a cushion, against the sound

side of the tooth, and the condensing point against the filling; force is applied by pressing the handles together. In this way

Fig. 114.



as much pressure may be exerted upon the filling as the tooth will bear. It is only, however, in the fewest number of cases that this instrument can be advantageously employed. The credit of the invention belongs, we believe, to the late Dr. H. H. Hayden.

A tubercle, of greater or less size, is sometimes found on the anterior palatine surface of a molar, near the crown. Between this and the body of the crown, a deep depression is often seen, which becomes the seat of caries; but the removal of the diseased part, and the introduction of a filling is so simple, that a special description of the operation is not deemed necessary.

FILLING THE INFERIOR INCISORS AND CUSPIDS.

The operation of filling a lower incisor or cuspid is far more difficult than filling an upper. It is fortunate, therefore, both for the dentist and the patient, that the lower incisors and cuspids are less liable to caries than the upper.

The constant tendency of the lower jaw to change its position, is embarrassing to the dentist in operating on any of the teeth in it, and in case of the incisors and cuspids it is sometimes peculiarly perplexing. To prevent this, all the effort the operator can make with his left hand, is frequently required. From the backward inclination, too, of these teeth, it rarely happens that the gold can be introduced from the lingual side of the arch; consequently, it is necessary to make the space as wide anteriorly as posteriorly. But as the teeth are comparatively small, the separation, when made with a file, should be no wider than is absolutely necessary for the removal of the diseased

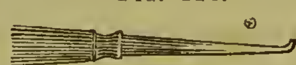
part and the introduction of the gold. When, however, it can be done with safety, the separation should be made with a piece of gum elastic or other substance between the teeth, in the manner before described.

While operating on the lower teeth, the head of the patient should occupy a more perpendicular position than while operating on the upper; this may be done either by lowering the seat or raising the head-piece of the chair. When by the latter, it will be occasionally necessary for the operator to stand upon a stool five or six inches in height.

In filling a cavity in the right approximal surface of a lower incisor or cuspid, the following method is recommended. The cavity being prepared, and a sufficient quantity of gold foil made into a small roll, or folded lengthwise, as the operator may prefer; with the left arm over the patient's head, the chin is gently grasped with the left hand, while the thumb is placed against the lingual surface of the tooth—the forefinger serving to direct the gold and point of the instrument, and also to depress the lower lip. The folds of gold in their introduction are pressed firmly against the lower wall of the cavity. The instrument employed for this purpose may be shaped like the one represented in Fig.

Fig. 115.

Fig. 116.



115, with a very small wedge-shaped point, and held as in Fig. 102. The consolidation of the gold may be effected partly with the same instrument, partly with a round-pointed one, shaped as shown in Fig. 116, and partly with an instrument shaped as in Fig. 104. The tooth should be firmly held between the thumb and fore-finger of the left hand, to prevent it from being moved in its socket by the pressure of the instrument.

When the incisors are very small, and the caries has spread over a large portion of the side of the tooth, it is often difficult to form a suitable cavity for the retention of a filling, without penetrating to the pulp cavity. In such cases, the patience and skill of the operator are frequently taxed severely in obtaining a sufficiently secure support for the gold. But this he can usually do, if he can make the bottom of the cavity as large as the orifice, even though it have but little depth.

The manner of introducing a filling in the left approximal surface is very similar. The left arm and hand, as well as the thumb and fore-finger, are all disposed of in the manner just described. The same instruments, too, may be employed for introducing and consolidating the gold, though, in the first part of the operation, the instrument (Fig. 100) may often be advantageously substituted for the one in Fig. 115.

Nothing has been said with regard to fillings in the labial or lingual surface of lower incisors and cuspids. Although caries rarely attacks either of these surfaces of a lower incisor, it does sometimes develop itself in the labial surface of a cuspid; but the operation of introducing a filling here is so simple, that a separate description of the manner of it is not deemed necessary.

FILLING THE INFERIOR MOLARS AND BICUSPIDS.

In filling a cavity in the grinding surface of a right lower molar or bicuspid, the operator may stand on the same side of his patient, and a few inches higher than while operating on an incisor or cuspid. With his left arm placed over his patient's head, the tooth may be grasped with the thumb and forefinger of the left hand, while the middle finger is placed by the side of the chin; the other two should be placed beneath it. After preparing the cavity, the gold may be introduced with an instrument like the one represented in Fig. 108, and held as shown in Fig. 102, pressing the folds against the posterior wall of the cavity.

In condensing the gold after the cavity is filled, use the instrument represented in Fig. 109. Sometimes, however, the one shown in Fig. 111, which may be held as seen in Fig. 96, answers a better purpose; but a greater amount of force can be exerted when held in the manner shown in Fig. 112, previously wrapping it with the corner of a napkin, to prevent the small part of the instrument from hurting the little finger. The kind of instrument, and the manner of holding it, will, after all, have to be determined by the operator. During the introduction and consolidation of the gold, the lower jaw should be firmly held with the left hand, to prevent it from moving and from being too much depressed. This precaution is the more necessary, as the muscles of the lower jaw and the articular ligaments are seldom

strong enough to resist the amount of force required in the operation.

In filling a cavity in the grinding surface of a tooth on the left side, the dentist may sometimes operate to greater advantage by standing on the same side. In this case, the commissure of the lips should be pressed back with the thumb of the left hand, placing it on or against the tooth to be filled, while the fore-finger passes in front of the chin, and the other three beneath it. As a general rule, however, he will be able to operate more conveniently by standing on the right side of his patient, and holding the tooth and chin in the manner before directed. In either case, the gold, in its introduction, should be pressed against the posterior wall of the cavity.

The foregoing general directions will be found, for the most part, applicable to the introduction of a filling in the approximal surfaces. When the crowns of the teeth are long, and the cavity situated near the gum, the operation is sometimes very difficult and tedious, requiring all the patience and skill the dentist can exercise to accomplish it securely. This difficulty is increased when the shape of the cavity is unfavorable for the retention of the gold; or, in other words, when the cavity is shallow and has a large orifice. There is also another very serious difficulty which the operator encounters in the introduction of a filling in the approximal, and also in the buccal, surface of a lower molar or bicuspid. The flow of saliva is often so profuse, that the whole of the lower part of the mouth is completely filled, and the tooth inundated before it is possible to introduce a sufficient quantity of gold to fill the cavity. This not only retards the operation, but it also renders it more difficult and perplexing; for it is necessary to force out every particle of moisture from the cavity and from between the different layers of gold, before the necessary cohesive attraction between them can be secured. If this is not done, or at any rate, if all the moisture is not forced from the cavity, and the gold sufficiently consolidated to render it impermeable to the fluids of the mouth, the operation will be unsuccessful.

Ordinary foil, sometimes called non-adhesive, when introduced in folds lying parallel with the sides of the cavity, keeps its place by the close lateral contact of the folds against each other

and the walls of the cavity. Hence such fillings may prove successful, although done "under water," provided the lateral pressure is sufficient to force out the saliva from between the layers of foil. But if the folds are laid in parallel with the bottom of the cavity, the operation will fail, in consequence of the scaling off of the successive layers which have no adhesion. Crystal gold and adhesive foil fillings depend for their success upon the perfect adhesion of their component pieces; therefore, the slightest moisture, or even dampness, whilst being introduced, is fatal to their durability.

For the purpose of obviating this difficulty, a variety of means have been proposed, but the one principally relied on consists in placing the corner of a soft fine linen napkin, or what is still better, fine tissue or bibulous paper, on each side of the tooth, so as to form a sort of dam or wall around it. This may sometimes be successfully done, but in many cases it will fail to accomplish the object, by increasing the flow of saliva, and is more or less embarrassing to the operator.

In the introduction of the gold on the right side, it may be pressed against the buccal wall of the cavity on the left side, against the lingual wall. Either of the instruments represented in Figs. 94 and 105 may be employed for the introduction of the gold, whether the cavity be situated in the anterior or posterior approximal surface of the tooth, and may be held in the hand in the manner shown in Fig. 102.

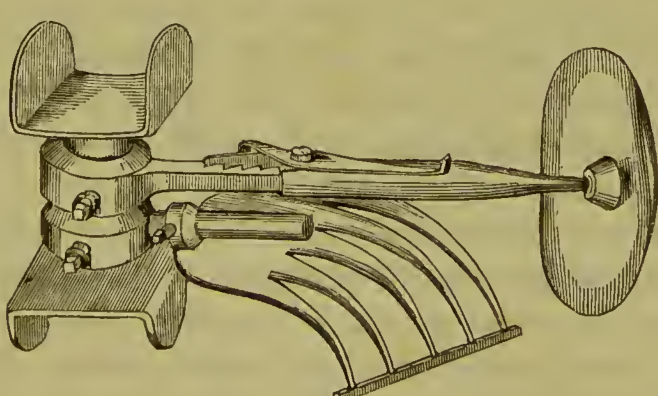
In filling a cavity in the lingual and posterior approximal angle of a first or second left bicuspid, and especially from the loss of the tooth behind it, when there is a backward inclination of the organ, great care is necessary to prevent the instrument from slipping and wounding the lower lip. The most convenient position for the operator in this case is on the left side and partly in front of the patient. The tooth may then be firmly grasped between the thumb and fore-finger of the left hand, or the thumb alone pressed against the outside of the tooth; in either case it is to be used as a rest for the ring-finger of the right hand, during the introduction and consolidation of the gold. But the locality of the cavity is such, especially when the mouth of the patient is small, that it can only be seen with great difficulty. Hence the operator is constantly liable to place the point of the

instrument on one side of the orifice against an overlapping portion of gold, which, when pressure is applied, is cut through or detached. The instrument thus comes in contact with the hard, smooth enamel, and unless the hand is so guarded as to control its motions, it is liable to slip and wound some part of the mouth, especially the lower lip: which accident, unless proper precaution is observed, may occur in filling any tooth.

Among the principal difficulties which the dentist encounters in filling a cavity in the buccal surface of a lower molar, apart from that of keeping the cavity dry until the gold is introduced, is the contact of the lower and inner part of the cheek with the tooth. This may, to a considerable extent, be prevented, and the commissure of the lips at the same time pushed back, with the forefinger of the left hand of the operator; which also will serve, when the cavity is shallow and the orifice large, to hold the gold in place, until a sufficient quantity is introduced to obtain support from the surrounding walls: it is sometimes, however, attended with much difficulty. In operating upon the bicuspids, it is only necessary to depress the corner of the mouth to obtain free access to the cavity.

An instrument has been invented by C. C. Thomas, of Louisiana, for the purpose of keeping the cheek from the buccal surface of the lower molars, depressing the tongue and holding the jaws at a sufficient distance apart.

Fig. 117.



It consists of (Fig. 117,) two grooved plates to admit the molar teeth, which may be separated or brought together by a screw working in a cylinder. Around the cylinder are two collars which can be tightened by set-screws: to the lower is soldered a

rod on which moves a ring holding a hand-shaped tongue-holder: to the upper is attached a highly polished oval concave plate, connected with the shaft by a ball and socket joint; the shaft itself is capable of extension by a ratchet movement. The instrument is ingeniously contrived so that its several parts can be moved in any required direction and extent. Its application is obvious: it opens the mouth, keeps the tongue and cheek out of the way, and the oval mirror throws light on the cavity. The author has not tested its practical value, but thinks it might be advantageously used, especially in operating on the left lower molars.

For the introduction of the gold on the right side, either of the instruments, represented in Figs. 95 and 105, may be employed, but on the left side the latter will generally be found most convenient. A straight wedge-pointed instrument, (Fig. 118,) can often be advantageously used in introducing the foil in either of the right bicuspids, and sometimes even in the first molar. This instrument can also often be used in filling a cavity in the grinding surface of a molar of either jaw, but oftener in the upper than the lower. It is scarcely necessary to say, that the introduction of the gold should commence behind and proceed forward. The instruments represented in Figs. 98, 106 and 107, may be used in consolidating the foil.

Fig. 118.

It may be well to mention here, that in filling a molar or bicuspid on the left side in the lower jaw, whether in the grinding, approximal or buccal surface, the back of the chair, if so constructed as to admit of being moved, should be thrown five or six inches farther back, to lower the head of the patient and give the face a more horizontal inclination. By this means the operator is enabled to approach the locality of his manipulations with greater ease, thus enabling him to exercise a more perfect control over his instrument, as well as over the mouth. But if the back of his operating-chair is stationary, he should stand upon a stool of five or six inches in height.

When the cavity is situated near the gum, or when the lower part of it runs a little under its margin, the precaution of removing all the overlapping portions ought never to be omitted, and

this sometimes constitutes a difficult part of the operation. For this purpose, the file represented in Fig. 119, may be very ad-

Fig 119.

vantageously used. Some are made straight at each end, others are curved. These valuable instruments were invented by Dr. Elisha Townsend; they are very useful, not only for the purpose just stated, but also for filing down the surplus gold of a filling in the approximal and other surfaces of all the teeth.

The profession is now well supplied with these files, having an almost endless variety of shape, size, and fineness of cut. It is difficult to over estimate the utility of these indispensable instruments. Different makers seem to vie with each other in devising new forms. A valuable modification has lately been suggested by Dr. Edward Maynard. It is to make the two ends different—not in shape, as is usually done—but in the direction of the file cut: or rather to have the file on each end set in the *same* direction, marked by an arrow on the shaft. Thus one end will cut *toward* the other *from* the operator; which, as the two movements are constantly required upon the same filling, adds greatly to the value of the instrument. Whereas a difference in the shape of the two ends is rather an annoyance, and precise similarity of no use except on the score of economy.

The foregoing details, with regard to the manner of filling teeth, will serve as a general guide for the performance of the operation; and at the same time, give to the student and inexperienced practitioner, some idea of the amount of labor, accuracy of manipulation, and perfection of execution, it requires.

The manner of building up the whole or part of the crown of a tooth, will be described in a subseqent chapter.

CHAPTER FIFTH.

FILLING TEETH WHEN THE LINING MEMBRANE IS EXPOSED.

The propriety of filling a tooth after the invasion of the pulp cavity by caries, without first destroying the pulp, is doubted by many practitioners. It is thought that inflammation and suppuration of the lining membrane and pulp must necessarily result from the operation. But Dr. Koecker, who was the first to recommend filling a tooth under such circumstances, cites a number of cases in which he performed the operation successfully. He also expresses the belief that "on an average, five out of six teeth may be preserved alive, and rendered useful for a long while." The author has been, since 1846, in the constant habit of filling teeth under such circumstances, whenever a favorable case presented itself, and occasionally for nearly twelve years previously to this period; and his experience warrants the belief, that the vitality of even a larger proportion may be saved under skillful treatment. He believes he has been successful in at least fourteen cases out of every fifteen, since 1853; and it may be, as he has stated in another place, that when the treatment of teeth in which caries has penetrated to the pulp-cavity shall be better understood, the vitality of a still larger relative proportion may be preserved. But so long as it can be done in even nine cases out of ten, the operation must be regarded as valuable; for a healthy living tooth is less liable to become obnoxious to the surrounding parts than one deprived of a large portion of its vitality.

Admitting the fact that teeth can, in many cases, be preserved alive after the lining membrane has become exposed, the question arises, does the pulp remain in the condition in which it is at the time the operation is performed? It is difficult to conceive either how a vacant space can exist between it and the filling, or how a foreign body can remain in contact with it, with

impunity. Drs. Harwood, of Boston, and J. H. Foster and W. H. Dwinelle, of New York, hold the opinion, from experiments they have made, that it ossifies. That some change of this sort does take place, is well known, and the transition is evidently the result of increased vascular action, caused by irritation. Examples of such ossification are met with in teeth in which the crowns have lost a considerable portion of their substance from mechanical or spontaneous abrasion; and it is a beautiful provision of nature to prevent the exposure of these delicate and highly sensitive parts. The same thing sometimes occurs in teeth which have suffered no loss of substance, and is doubtless the result of some constitutional or local cause of irritation.

These facts would seem to justify the conclusion elsewhere stated, that the pulp of a tooth, when subjected, for a sufficient length of time, to the influence of an irritating agent, capable of exciting only a very slight inflammatory action, undergoes ossification; or rather is converted into a substance resembling *crusta petrosa*, or what Professor Owen terms *osteo-dentine*. A tooth which has been filled after the lining membrane has become exposed, is liable, when it fails to undergo this change, either to perish from derangement of its nutritive functions, or to become the seat of active inflammation and suppuration. But something more than ossification, or conversion into *osteo-dentine*, takes place when a space is left between it and the filling. If this vacant space were not filled up, we have reason to believe that the slightest increase of vascular action would, as has been justly remarked by Dr. Elliot, force a portion of the pulp into it; and thus active inflammation would be excited by contact with the sharp angles of the walls of the cavity, and this, as a natural consequence, would be apt to terminate in suppuration. We believe, from experiments which we have made, that nature, ever fruitful in her resources, uses means for the prevention of such an occurrence: consisting, first, in filling the vacant space with coagulable lymph, effused from the lining membrane or exposed surface of the pulp; then, in its organization, and, lastly, its conversion into *bone*, or more properly, *osteo-dentine*. Nature seems to employ here the same means as in other parts of the body, for the reparation of injuries.

When this reparative process does not take place after the

operation, it may be owing either to want or the excess of vascular action in the lining membrane or pulp. A certain amount of increased vascular action seems necessary to the effusion of coagulable lymph, an indispensable requisite; but when this is too great, it must of necessity terminate in suppuration. It is obvious, therefore, that the success of the operation must very greatly depend upon the circumstances under which it is performed. If these be unfavorable, all efforts to preserve the vitality of the organ will, in a majority of cases, prove unavailing; however skillful the operator may be in the preparation of the cavity and the introduction of the gold. The health of the patient should be unimpaired; the tooth of a tolerably good quality, free from pain at the time the operation is performed; it should never have ached; and the pulp, peridental membrane and surrounding parts should be in a perfectly healthy condition. The cavity should be of a proper shape for the easy introduction and permanent retention of the filling; and the smaller the point of exposure of the lining membrane, the greater the prospect of success. It is also important that every particle of completely decomposed dentine be removed, and if there be any oozing of blood from the ruptured vessels, this must cease before the filling is introduced.

Dr. Koecker's method of performing the operation is as follows:

First.—Remove the caries and give to the cavity a proper shape for the reception and retention of the filling; then with a little raw cotton moistened in warm water, free it of all dust that may be in contact with the pulp. *Second.*—If the lining membrane is not wounded, dry the cavity, and place a small plate of thin leaf lead over the exposed nerve and surrounding dentine; then fill the cavity in the ordinary way with gold. *Third.*—When the lining membrane is wounded and bleeds, cauterize the part with an iron wire, heated to a red heat, using the precaution not to wound the pulp. After the hemorrhage has been arrested and an artificial cicatrix formed, free the cavity from all loose extraneous matter, then cover the nerve with sheet lead and fill as before directed. The reason assigned by Dr. Koecker for covering the nerve with lead, is that it has a "more cooling and anti-inflammatory effect" than gold. He also states that

when he employed gold exclusively, he was seldom successful, and that inflammation, pain, etc., generally supervened, rendering the removal of the filling necessary.

The foregoing method of treating an exposed dental pulp has not proved so successful in the hands of other practitioners. It has been found that inflammation and suppuration supervene in a large majority of the cases, especially when the cautery is used; the practice is now seldom resorted to. The direct application of any metallic substance to the lining membrane or pulp, is, according to the observation of the author, very apt to be followed by inflammation and suppuration of these tissues. Some of the vessels of the lining membrane are always necessarily wounded in removing the last layer of decomposed dentine, but the hemorrhage, when no other injury is inflicted, is very slight, and sometimes scarcely perceptible; so that the operation of filling need never be delayed more than from three to ten minutes. The application of a small particle of raw cotton moistened with spirits of camphor will immediately arrest it.

Dr. S. S. Fitch proposes to cover the nerve when exposed, with a plate of gold, previously to filling the cavity; and this, in the opinion of the author, is preferable to the direct application of a piece of leaf lead, as recommended by Dr. Koecker. It is certainly a better protection to the nerve, and if it be fitted to the cavity so that its edges shall rest upon the surrounding dentine, a filling may afterwards be introduced without injury to the pulp. Still, in many cases the application of a covering of this sort is objectionable. It is difficult to fit it with sufficient accuracy to prevent the liability to displacement in the introduction of the filling; and when the cavity is very shallow it will occupy so much room as to render it impossible to fill the remainder of it in a substantial manner; yet it may sometimes be very advantageously applied.

The plan pursued by Dr. J. H. Foster, in filling teeth after the pulp has become exposed or is covered only by a very thin layer of dentine, is as follows: "If," says he, "after a careful removal of all the defective portion, within and about the parietes of the cavity, the thin layer of bone which lies adjacent to the lining membrane has a moderate degree of consistency, yet not sufficient to protect the dental pulp from irritation caused

by the pressure of external agents; it has been my practice to leave it there, and after fitting a gold cap over it (with great caution as to its proper adjustment as a protection), proceed to fill the tooth." But this method, he says, was not as successful as he could have desired, owing, as he supposed, to the extent to which the thin subjacent layer of dentine had been involved in disease, and to the liability of the pulp to be affected by heat and cold.

To guard against the irritation and inflammation proceeding from this cause, he fills the concave surface of the gold cap with Hill's stopping; using the precaution to preserve the concavity, so that it may not press upon the part it is designed to protect. This treatment, he says, proved successful in a majority of cases. Believing that many failures occurred in consequence of the comparatively small portion of newly exposed bone which was covered and protected by the non-conducting medium, he resolved to try still another experiment. Instead of lining the gold cap, after having fitted it accurately upon the floor of the cavity, he filled the *whole* of the cavity external to it, with Dr. Hill's composition, allowing this to remain for five or six months as a *temporary* stopping.

By this plan, Dr. Foster says he has, with one or two exceptions, been successful in preserving the vitality of the tooth in every case treated during the past year (1850). He also states that he has occasionally removed these fillings after the lapse of two or three months, and finding the irritability of the tooth still existing, he refilled them in the same manner and permitted the filling to remain two or three months longer; on again removing the stoppings, he found the inflammation diminished, and the subjacent layer of bone almost firm enough to bear the pressure of a gold filling; but he still uses the cap underneath the gold, as before. He believes however that, if Hill's stopping could be relied upon for preserving the walls of the cavity for one or two years, as perfectly as it does for a few months, the caps might be removed and a solid gold filling introduced, without danger of causing irritation by pressure upon the bottom of the cavity. He further adds, that he "has frequently taken out gold fillings of his own insertion, by way of experiment, which had been introduced under like circumstances, after they had

been in for two or more years, and on removing the cap, had found the bone beneath so unyielding and void of sensibility, that he was able to introduce a solid gold filling without the cap." The author had, in 1848, a case (first left upper molar) in which he removed a suppurating pulp, and, after treating for ten days with injections of chlorinated soda, filled the cavity with Hill's stopping. The patient was requested to call in three weeks, or sooner; but put it off for two years. On removing the temporary filling for the purpose of introducing gold, the walls of the cavity were found to be as perfect as when it was inserted.

That Dr. Foster's method of treatment by means of gutta percha has justified the expectations which he many years ago formed of it, may be inferred from the following extract taken from a letter, written in 1863, to a professional friend. The importance of the subject will, it is hoped, excuse this use of a letter not written with any thought of publication:

"I would I could speak trumpet-tongued to the members of my profession upon the importance of an expectant course of treatment in *preventing* exposure of the nerve. I now rarely expose a nerve in preparing a cavity. If there has been neither inflammation in the dental pulp, nor pain previously to the operation, I avoid cutting too deep and prepare the cavity as for a gold stopping. But if I consider there is the least danger of inflammation from the pressure of the gold or from the action of heat and cold through the metallic medium, I invariably pursue the *expectant* course of treatment.

"I use for this purpose Hill's stopping, renewing it, if necessary, until all local irritation has ceased and the interior of the cavity has attained a degree of hardness, such as will safely permit the insertion of a solid gold filling. This usually occupies a year.

"Fang filling, treatment of the pulp, of abscess, &c., all demand our most serious consideration. But still more important is it for us to inquire if there is not some mode of treatment which will prevent these evils. Hence I think this method of prevention, here so briefly stated, demands the most careful attention of every practitioner."

The method pursued by the author, in filling a tooth after caries has penetrated to the pulp-cavity, is a very simple one.

The caries is removed and the cavity prepared in the usual manner, using the precaution not to wound the lining membrane if it can be avoided; though some of its vessels are always ruptured in the removal of the last layers of decomposed dentine; then, the cavity is wiped out very carefully with a dossil of cotton saturated with spirit of camphor, which immediately arrests the effusion of blood. The gold is next introduced, commencing by placing the folds on one side of the cavity, and inserting fold after fold, without carrying to the bottom of the cavity those immediately over the exposed part of the lining membrane or pulp; thus every part, except a very small space immediately over the nerve, is thoroughly filled. The folds are forced so tightly one against the other, as to prevent, in the consolidation of the outer extremities of the folds, the liability of pressing their inner extremities against the exposed pulp at the bottom of the cavity. After the gold has been thoroughly condensed, the surface of the filling is finished in the usual manner.

The author has occasionally placed a drop of the solution of gutta percha or collodion in the bottom of the cavity, waiting until the chloroform had completely evaporated, before introducing the gold. Dr. Elliot, of Montreal, states in an article on filling teeth over exposed nerves, that he places the gold "directly upon the living nerve, and in perfect contact with it, over the whole of its exposed surface," using, when the cavity is sufficiently deep to admit of it, *asbestos*, a non-conductor, "*enveloped in a few thicknesses of gold foil.*" He also says, that within the last year he had but two cases in which irritation advanced so far as to become troublesome to the patient; and that, in both instances, perfect and permanent relief was obtained by the use of leeches and a mild cathartic. We are inclined to believe, however, that by leaving a vacant space between the filling and the pulp, the success of the operation will be rendered more certain. The result of the operation, however, performed in either way, cannot always be immediately ascertained. Though it may at first be apparently successful, suppuration of the lining membrane and pulp may take place, three, six, or even twelve months after the introduction of the filling; hence we should not decide too quickly upon the results of any given treatment.

Dr. S. P. Hullihen described to the author, in the fall of 1851,

a method which he had recently introduced of treating teeth after the lining membrane had become exposed. It consists, after filling the tooth in the usual way, of drilling a hole with a small spear-pointed drill, about a line above the edge of the alveolus through the gum, alveolar wall and root into the pulp-cavity, using the precaution not to separate the nerve, and wounding it as slightly as possible. The effused lymph resulting from the inflammation occasioned by the pressure of the filling, escapes through this opening; which, he believes, when the increased vascular action subsides, is filled with callus, and ultimately with dentine. Dr. Hullihen informed the author that he had succeeded in almost every instance in preserving the vitality of the tooth. The author has not performed the operation often enough to enable him, from personal experience, to express an opinion as to its merits; but owing to frequent failures he believes that it is now seldom if ever performed.

We have now, without going into detail, given, in as few words as possible, all the information we possess on the subject of filling teeth, after the lining membrane has become exposed; embracing the result of our experience since the publication of the fourth edition of this work. Our confidence in the utility of the operation, as the reader may perceive, has very greatly increased.

CHAPTER SIXTH.

FILLING PULP CAVITIES AND ROOTS OF TEETH.

This operation has now become very common. It is more or less practiced by many dentists in America, and in Europe, although its propriety is still doubted by many. The objection to the practice is founded upon the supposition, that, in proportion as the vitality of a tooth is lessened, it becomes obnoxious to the surrounding living parts.

It is contended that, though the presence of the tooth may not give rise to alveolar abscess, it is to some extent a local irritant; that as such it must necessarily exert a morbid influence, not only upon the living parts with which it is in immediate contact, but, also, upon the whole economy. Hence it is argued, that the proper remedial indication, after the death of the lining membrane, is the extraction of the tooth. This reasoning, it must be admitted by all who have any knowledge of the laws of health and disease, is not without much seeming plausibility. Until within a comparatively recent period, the result of most of the efforts made for the preservation and retention of teeth in this condition, fully justified its supposed correctness; for, in nine cases out of ten, the operation of filling, unless an opening was left for the escape of the matter secreted at the extremities of the root, was followed, sooner or later, by alveolar abscess. The conclusion, therefore, that such teeth could not remain in the mouth with impunity, was a very natural one. But more recent experiments have shown that this is not a necessary consequence.

Drs. Maynard and Baker were the first to show that most of the morbid phenomena resulting from the presence of a tooth in the mouth after the destruction of the lining membrane, arose from the irritation produced by the matter contained in the pulp-cavity and canal of the root. To prevent their occurrence, therefore, they proposed filling both cavity and canal in such a manner

as eompletely to exclude every thing else. The aeeumulation of purulent matter being prevented here, its secretion at the extremity of the root will, in a majority of eases, either eease altogether, or go on no faster than it is reabsorbed, as has been shown by repeated experiments. Thus it would seem that the amount of vitality whieh a tooth derives from the investing membrane is suffieient, ordinarily, to prevent it from exerting any apparent morbid aetion upon the surrounding parts.

Although it is desirable that the operation should be performed before any diseased action has been set up at the extremity of the root, mueh advantage may sometimes be derived from it even after alveolar abseess has aetually oecurred. Dr. Maynard informed the author, that he had sueeeeded in euring the disease by it. Other dentists have also done it, and the author has certainly known, in several instanees, great benefit result from eleansing and filling the roots of teeth whieh had given rise to abscess. The diseharge of matter has, in most eases, on whieh he has operated, been greatly diminished; often subsiding altogether for several months at a time, the recurrence rarely oeeasioning much ineonvenienee, or eontinuing for more than a week or ten days. Still, he does not feel warranted, from his own observations and experience, in reeommending the operation in cases of this sort, unless the preservation of the tooth is ealled for by some peeuliar necessity.

During the year 1849, Dr. J. H. Foster filled the pulp-eavities and roots of forty teeth, with the following results:

	No Abscess.	Abscess.	Successful.	Unsuccessful.
Superior molars, . .	2	1	3	
Inferior molar, (inflamed,)	1		1	
Superior bieuspids, . .	8	1	8	1
Inferior do. . .	2	2	4	
Superior euspids, . .	6	1	7	
Inferior do. . .	1	1	1	1
Superior ineisors, . .	12	1	13	
Inferior do. . .	1		1	
	33	7	38	2

In the case of the superior bicuspid, marked unsueeessful,

Dr. Foster says, the patient would not submit to the pain, and insisted upon the removal of the tooth during the incipient stage of alveolar abscess. In that of the superior cuspid, the abscess did not form until some months after the operation. It was opened in due time, but as the parts still continued painful, an attempt was made to remove the filling. This was unsuccessful, and as the pain continued, the tooth, which he had filled into the root from a cavity in the labial surface, was extracted. The fang was of an unusual length, and had a bold lateral curvature about three-fourths of the way to the apex, rendering the passage of an instrument beyond the angle impossible. He had, however, forced the first piece of foil a little beyond this curve, which resisted all efforts for its removal. The fang beyond this point had become discolored and the periosteum inflamed.

The application of creosote to the inner walls of the sac, introduced through the canal in the root, previously to filling, has been recommended as one of the most certain means of cure. It was first recommended by Dr. C. W. Ballard, and has been tried by the author with very gratifying results. It is introduced on the end of a thread of waxed floss silk to the sac at the extremity of the root, through the pulp cavity and canal of the fang, previously freed of all extraneous matter. Another, and in some respects a better mode of applying this agent to the ulcerated inner surface of the sac, recommended by Dr. F. H. Badger, is to throw it into the tooth with a syringe, the opening in the crown being first closed with a piece of caoutchouc, with a perforation large enough to admit the tube of the instrument. The creosote is used in the form of a strong alcoholic solution, say one drachm of creosote to an ounce of alcohol. This being forcibly injected into the tooth, passes through the sac at the end of the root and escapes through the fistulous opening in the gum, where it is caught in a piece of soft sponge or a few folds of bibulous paper. There are many cases in which there is simply a slight morbid secretion that escapes through the tooth without any discharge from the gums. The means most efficacious in arresting this are the same as those recommended for the treatment of abscess of the socket; the creosote, in this case, should be introduced in the manner as first described.

Dr. E. J. Dunning stated in a letter to the author, in 1850,

that he had been for several years, and was then constantly in the habit of filling the fangs of teeth after destroying their nerves, and also of cleansing and filling the fangs of teeth which had previously lost the entire pulp and become more or less diseased. He also stated that very few cases had occurred in his practice where suppuration had supervened, rendering the removal of the tooth necessary. He furthermore remarks, that whenever the investing membrane and gums of teeth, treated in this manner, become thickened and swollen, the symptoms are less severe. In proof of the correctness of this opinion, he has furnished the author with the following details of a case which came under his observation.

"A gentleman from the south called immediately after his arrival in this city, and stated that during his passage in the steamer, he had been suffering intensely from pain in a first superior molar. On examination I found the tooth thoroughly injected with red blood and the periosteum highly inflamed and considerably thickened, though there was no swelling of the gum. A small cavity in the posterior approximal surface had been filled with gold a day or two before sailing. In preparing the cavity for filling, arsenic had been used to allay sensibility. In most cases I should have advised the removal of the tooth, for the symptoms were very unfavorable to any operation for its preservation. But as the mouth was otherwise perfectly healthy, the arch unbroken, the cavity in the tooth very small, and the patient extremely anxious to preserve it, I determined to make the trial.

"On examining the cavity carefully, I found that the nerve had never been exposed: the arsenic had acted upon it through the circulation, and had thus produced this severe inflammation. Having removed the layer of sound bone that covered the nerve, and finding it quite sensitive, I made an application of an exceedingly small quantity of a mixture of arsenic, morphine, and creosote, and covered it with a metallic cap or arch, to prevent pressure, followed by a loose filling of tin foil. The pain and much of the soreness were immediately relieved.

"Saw the patient again on the fourth day—found the soreness entirely gone—had suffered pain since the application was made—injection remained the same. Found the part of the

pulp contained in the central cavity entirely insensible—removed it; finding the portion in the fangs still sensitive, made the same application at the entrance of each canal and filled the cavity again with tin. At this sitting ventured to file the tooth so as to increase the separation between it and the second molar. The filed surface showed the injection beautifully, the bone appearing a bright red, and the line at the junction with the enamel very distinct. In three or four days saw the patient again, and to my surprise and delight found that the injection had entirely disappeared, and the tooth almost as perfect in color as any of its neighbors. The nerve was then removed from the fangs, and its place filled with gold, and at a subsequent sitting the external cavity was filled. As three months have elapsed since the operation was performed, without hearing from it, I conclude that it is thus far successful."

Other cases of a similar character, and with similar results might be given. The injection of the tooth from the vessels of the lining membrane and pulp, is of frequent occurrence in teeth to which arsenic is applied for the purpose of merely destroying the sensibility of the dentine. At the first meeting of the American Society of Dental Surgeons, Dr. Hayden mentioned a case that had a short time before fallen under his observation, and several others were cited by the author at the same time. Since then he has met with numerous cases in which this had occurred. It is doubtless the result of increased vascular action, excited in the lining membrane and pulp by the action of the arsenic, and it proves that the vessels of teeth, under certain circumstances, are capable of conveying red blood. It occurs, however, much more frequently in the teeth of young than in those of old persons.

With regard to the best means of destroying the nerve, or rather the pulp of a tooth, there exists much diversity of opinion. Immediate *extirpation* with an instrument, *arsenic*, and the *actual cautery*, are those most frequently employed, and each has its advocates.

To the use of arsenic and all similar agents, Dr. Harwood, of Boston, is strongly opposed. He states, in a letter to the author, written in 1850, that "they cause death and sloughing in the parts to which they are more immediately applied, and irritation

and unmanageable trouble in the parts next beyond those they absolutely kill. In other words, they *irritate* the parts beyond the dental cavity, and from this cause (and perhaps from chemical injury to the tooth itself), the periosteum of the root and socket becomes the seat of great, and frequently of uncontrollable difficulty." Entertaining these views, he regards the use of such means as opposed both to experience and sound philosophy; and adopts, without knowing that the same thing had been done by others, what he believes to be a more correct practice—immediate extirpation. He thus describes his method of accomplishing this object.

"I first effect such an opening as will enable me to approach the exposed pulp, in the line of its axis, or as nearly so as circumstances will permit. Then, having carefully but sufficiently exposed the surface of the pulp, I pass down to the apex of the root, through the pulp, a small untempered steel instrument, with a trocar-shaped point, and revolving it once or twice, sever the vessels and nerve. This, as any one knows, who is accustomed to inserting artificial teeth, produces but a slight and momentary pain. I then, by means of minute instruments, adapted to the purpose, endeavor to remove every portion of the severed pulp and lining membrane, and as soon as the hemorrhage ceases, dry and fill the cavity.

"I have sometimes only filled the canal at the first sitting—leaving the body of the tooth to be treated after a few days. This course has been adopted from a fear that the pressure necessary to complete the whole operation might enhance the danger of inflammation and suppuration." This is prudent, but experience does not convince me that it is necessary.

"It should be borne in mind, that at the point where the vessels and nerve in question enter the root, the passage is much smaller than it is immediately within. This strait will be easily recognized when reached, by the touch, the instrument appearing to be arrested by an obstacle, and not by being wedged in a narrow passage. Care should be taken, I think, that the instrument is not allowed to pass through the strait, either by being too small, or by being revolved there till it cuts its way through. For, by wounding the parts without the tooth, and forcing par-

ticles of bone out upon the parts external to the root, the danger of an unfavorable result would be greatly increased."

Dr. Harwood adds, in conclusion, that he believes it is better to make the division of the parts a little within the strait, though he does not regard the matter as being yet fully settled by observation and experience. As to the success of the practice, he speaks very confidently; not having had a case treated in this manner, where the patient and pulp were healthy, in which there has been a single symptom of alveolar abscess.

In a paper read before the American Society of Dental Surgeons, at the meeting held in the city of New York, August, 1845, and published in the sixth volume of the American Journal of Dental Science, p. 15, Dr. E. J. Dunning maintains very similar views with regard to the means most proper to be employed for the destruction of the pulp of a tooth. He says,

"The destruction of the nerve by mechanical means has been practiced to a small extent by dental surgeons for many years; but on account of the severe pain which in many cases attends it, as well as from the fact that, in the manner in which it has generally been practiced, it has proved no more successful than other and less severe methods; it has been considered rather in the light of a *dernier resort.*" This he believes to be owing to the fact, that the nerve is often only punctured and lacerated, and afterwards shut up in the tooth and left to decompose. To prevent which, he says, the whole nerve should be removed, and its place filled with gold or tin foil.

Again, Dr. Dunning remarks: "The instrument which I have used to excavate the fangs, is a delicate probe of steel, perfectly annealed. The point should be converted into a very slight hook, and made sharp, so as to bring away the nerve or other matter with which the cavity may be filled. For the removal of the nerve in the chamber of the crown, in molar teeth, as well as for enlarging the cavity, so as to give free access to each of the fangs, a burr-drill is very useful. As these teeth are generally very much decayed, it will be found advisable, when the cavity is on the side of the crown, to remove its edges in such a manner as to admit the light directly upon the openings of the fangs. This will facilitate the operation very much, and at the same time give strength to the walls that are to contain the

stopping." When the nerve has been destroyed in the manner above described, Dr. Dunning says that the operation, so far as he has been able to observe, has been successful in every case.

On the different methods of destroying the nerve, Dr. J. H. Foster says: "It is a difficult matter, and I have generally found it utterly futile to attempt to induce patients to submit to the removal of the pulp by *extraction* or *excision* with *instruments*, in those cases in which it becomes necessary to destroy vitality before the teeth can be filled. To obtain the consent of the patient by a representation of the advantages, in its immediate effects, of this mode of treatment by *extirpation*, as contrasted with the more slow and uncertain practice, by the aid of *chemical agents*, has been my earnest endeavor. I do not remember a single case of the removal of the dental pulp by an instrument—the gold being inserted into the dental cavity immediately after the hemorrhage has been checked—which has resulted in alveolar abscess."

Dr. Foster, however, generally employs arsenious acid, with sulphate of morphia, one part of the former to four of the latter, applied on a small pellet moistened with creosote. After applying this directly over the nerve, he covers it with a cap, to avoid pressure; then fills the external cavity with some soft material which will exclude moisture. At the end of forty-eight hours he enlarges the dental cavity, removing its contents to the apex of the root; then, after waiting another forty-eight hours, he proceeds to fill the canal, leaving the cavity in the crown to be filled at a subsequent sitting.

In performing this operation on molar teeth, where there is a probable chance of a favorable issue, and the preservation of these teeth is particularly called for, he thinks it important that the excavation should be done at intervals, so as to cause as little irritation at each sitting as possible, and that the filling of the different cavities in the tooth be also proceeded with in like manner.

Dr. Maynard—who has been as successful in filling the pulp-cavity and roots of teeth as any other practitioner, and has probably had more experience, having been in the habit of performing the operation since 1838—having thoroughly tested the method of destroying the nerve by immediate extirpation with

an instrument, as well as that by the application of arsenious acid, gives the preference to the latter. His method, as described by Dr. Westcott in vol. 7, p. 286, of the American Journal of Dental Science, is as follows:

He takes white wax, and works it into cotton or lint till it is thoroughly mixed together. With this he fills the cavities in the tooth. But, before doing this, he exposes the nerve as much as possible, applies the arsenic, and *caps* the orifice with a cup-shaped plate of lead, the convex side outwards. While this is carefully kept in place, he fills the cavity with the cotton and wax, very carefully and perfectly, in such a way as not to shut in and compress any air which might press upon the nerve. This packing, as introduced by Dr. Maynard, will keep the "medicine," as he terms it, perfectly dry for twenty-four hours, or longer.

After removing this packing and the preparation, he proceeds to remove the nerve. Instead of attempting to do this at once, he begins by cutting on every side of the orifice, so much enlarging it as to be enabled to remove the nerve without pressing the contents of the cavity upwards.

His probes are objects of peculiar interest, especially those for extirpating the nerve. Some of them are made from the main-spring of a watch, by filing or grinding them sufficiently narrow, to enter the smallest space which he wished to probe. In this way he secures the most perfect *spring temper*, a point not easily attained in so frail an instrument as a probe adapted to this purpose. These probes are bearded by cutting them with a sharp knife—the beard pointing backward. With different sizes of these and other probes, and by enlarging the cavity from time to time, he removes the nerve to the extremity of the root.

His operation of filling the root is characterized by great neatness and dexterity. His instruments are of the most delicate kind, and are adapted to reach to the end of the fang, although the canal may not be entirely straight. In filling these roots he uses very heavy gold, we believe from Nos. 12 to 30. This is cut into strips corresponding to the diameter of the cavity, and is not doubled. The end of one of the strips is laid upon the end of one of his delicate pluggers, and carefully

carried up to the upper extremity of the root. This being effected, the instrument is withdrawn a slight distance, then returned, carrying with it another portion, till the strip is exhausted. In this way the whole root is filled: the cavity in the crown is then filled in the usual manner.

Dr. Arthur, in a series of ably written articles, published in the American Journal of Dental Science, on the treatment of caries of the teeth, complicated with disorders of the pulp and peridental membrane, recommends the use of cobalt for destroying the nerve as preferable to any other agent or means that have been employed for the purpose.

In the destruction of the pulp of a tooth the author has employed both mechanical and chemical agents. He has been in the habit, for more than twenty years, of occasionally extirpating the pulp to the extremity of the root by introducing a very small untempered instrument, with a spear-shaped point; though not at first with the view of afterwards filling the pulp cavity. He has also used the actual cautery and arsenious acid. To the last named agent, as used by most dentists for destroying the vitality of teeth, he was at one time strongly opposed, and still believes a vast amount of injury is produced by it; but with proper care and judicious after-treatment, it may be used with safety, and, in most cases, with advantage. He now employs it for destroying the vitality of the lining membrane and pulps of the molar and bicuspid teeth, and occasionally applies it to the incisors and cuspids. As a general rule, however, when he wishes to destroy the nerve of one of the last named teeth, he extirpates it by thrusting a small instrument up the pulp cavity to the extremity of the root. When he uses arsenic, he applies about the thirtieth or fortieth part of a grain, with an equal quantity of sulphate of morphia; placing it on a small piece of raw cotton, moistened with creosote or spirits of camphor, and sealing up the cavity with white or yellow wax. At the expiration of seven or eight hours, he removes the wax and arsenic, and afterward the pulp of the tooth. If the portion in the root is still sensitive, he applies it a second time; but he seldom finds it necessary to do so. The method which he adopts in filling the root, or roots of a tooth, is the same as that pursued by Dr. Maynard.

It sometimes happens that the canals in the buccal roots of the upper molars are so small as to preclude the introduction even of a small sized hog-bristle. In cases of this sort, it is impossible to fill them, and fortunately, from their small size, they cannot serve as reservoirs for the accumulation of morbid matter. The canal in the palatine fang is always much larger than in either of the buccal roots, and in a majority of the cases is filled with comparative ease.

The following is the method of treatment, preparatory to filling the fang, pursued by Professor Gorgas, of the Baltimore College: "I remove carefully all disorganized pulp and decomposed dentine; also all discolored dentine, provided it does not weaken the walls of the cavity. Then syringing out all loose particles of the debris with tepid water, I dry the canal to the apex of the fang with floss silk; being careful to leave an end projecting so as to permit its easy removal. Several such pieces being used, a shorter piece is then saturated with creosote and passed to the end of the canal, leaving a slight projecting piece in the pulp cavity, so that it may be seized with pliers when it is to be removed.

"I then introduce into the pulp cavity a temporary filling of Hill's stopping, gutta-percha, or cotton mixed with wax, or saturated with sandarach or shell-lac varnish. In twenty-four hours the canal is examined, and the creosote renewed if necessary. When not the slightest odor of purulent secretion is perceptible, I then apply on the floss silk chloroform mixed with white of egg, replace the filling, and wait for several days.

"If at the end of this time there is no trace of diseased action, I fill the canal with gold; then wait a few days until all chance of irritation from the pressure used in the operation has passed away, and then complete the filling. But not unfrequently it is necessary to repeat this course of treatment several times. In one case, two months were required before the tooth was in condition to warrant me in filling it.

"In some cases I deem it prudent to insert a filling of 'Hill's stopping,' for several months, especially when there is the slightest doubt of the arrest of the disease; for the gold once introduced into the canal, it is exceedingly tedious and difficult to remove it. Disease on the *outside* of the extremity of the

fang may be controlled by creosote and nitrate of silver applied through the fistulous or an artificial opening in the alveolus.

"Chloride of zinc may be used instead of creosote when the smell of the latter is particularly repulsive to the patient; and chlorinated lime or soda are excellent antiseptics. Any trace of the living nerve should be treated with arsenic, a minute portion of which may be introduced upon floss silk before commencing the creosote treatment."

We have now presented a condensed summary of most of the information we possess in relation to the operation of which we are now treating. Notwithstanding the favorable light in which it is viewed by many eminent dentists, we think it should be restricted to teeth, the presence of which in the mouth is called for by some peculiar or urgent necessity. It is only in such cases that we advise the operation; for occasional unsuccessful results have attended it, in the practice of those who have performed it many times; which proves that a tooth, after the destruction of the lining membrane and pulp, is more liable to give rise to a diseased action in the socket, than a tooth not deprived of these essential constituents. If these parts did not perform some necessary function, or contribute in some way to the well-being of the tooth, they would not be left there; the process of dentinification would doubtless be carried on until the cavity in which they are contained was completely obliterated. Still, as we have already stated, and as is fully proved by facts, they may often be removed without causing a tooth to exercise any immediate manifest hurtful action upon the surrounding parts or upon the general system.

It sometimes happens, where the central cavity has been filled for a length of time with black purulent matter, that the crown of a tooth, after the pulp has been accidentally deprived of vitality by the application of arsenic, used merely with a view of destroying sensibility, assumes a dark brown, and sometimes almost a black color: this, in some instances, extends to every part of the dentine of the crown; in such cases, it is important to restore the natural color of the organ, before filling. The agent which the author has employed for this purpose, for a number of years, is the solution of chlorinated soda. After freeing the pulp cavity to the extremity of the root of all impuri-

ties, and removing from its inner walls the softened or decomposed portions of dentine, he fills the tooth with cotton, saturated with this solution, closing the orifice with white wax, and permitting the whole to remain for twenty-four hours. A single application will sometimes produce the desired effect; at other times several are necessary. Dr. Dwinelle has used sucessfully, for the same purpose, a solution of lime, probably the chlorinated. The chlorine, in both the lime and the soda, is powerfully antiseptic and decolorizing.

CHAPTER SEVENTH.

FILLING TEETH WITH CRYSTALLINE OR SPONGE GOLD.

Two preparations of gold for filling teeth have, within the last few years, been brought to the notice of the dental profession, each differing somewhat in appearance and in properties, and both widely differing from foil or leaf gold. Each has a spongy texture and appearance, but one is composed of crystals, and the other of small granular particles. The former is more readily compressed into a solid mass, and hence has been found better adapted for filling teeth. But in the use of either of these preparations, a different method of procedure is required from that employed with foil; the instruments necessary to make a filling with the one, are, in many cases, unsuited for operating with the other. A separate description of the series of manipulations is, therefore, deemed necessary.

INSTRUMENTS EMPLOYED IN THE OPERATION.

The chief difference between the instruments employed for introducing and consolidating these preparations of gold in the cavity of a tooth, and those used for foil, consists mainly in having the working extremity blunt, varying in diameter from a line to a mere point, with cross cuts upon the surface, giving it a sharp denticulated appearance. Some original forms of instruments have been invented, but most of those used at present are mere modifications of instruments heretofore employed for filling teeth with gold foil.*

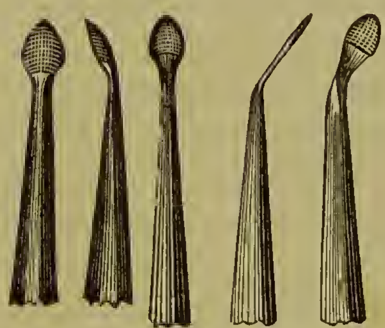
* A series of the most approved forms that have been devised for the purpose, are represented in an article by Dr. W. H. Dwinelle, published in the April No. of vol. 5, New Series, of the American Journal of Dental Science. Most of the cuts in this chapter are copied from them.

Fig. 120 represents an instrument with a round point, flat on one side and slightly convex on the other. It is used chiefly for carrying small masses of gold into the cavity and pressing them there. It is a convenient and useful instrument and cannot well be dispensed with in working these preparations of gold. Several sizes are required; the pattern was designed by Dr. W. M. Hunter.

Fig. 120.

An instrument somewhat similar to the foregoing is represented in Fig. 121. The point, instead of being round or circular, is oval, bent to a greater angle, with a slight oval on each side. It is intended more particularly for carrying and compressing small masses of gold in cavities on the approximal surfaces of teeth slightly separated from each other. It is better adapted for this purpose than any instrument at present used. Several sizes are needed.

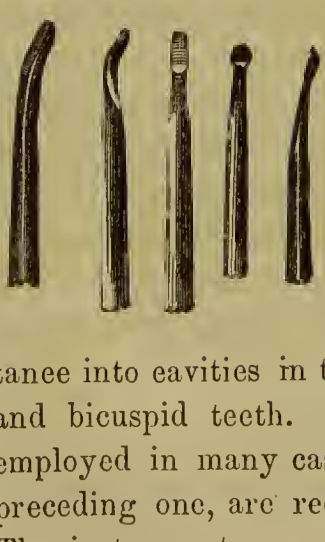
Fig. 121.



The working extremities of all instruments that are used for filling teeth with these preparations of gold, are cross cut, forming upon them numerous fine sharp points.

Fig. 122 represents an instrument slightly bent at the working extremity, the upper surface flat, and terminating in a blunt point. It is designed chiefly for introducing and compressing the gold in the grinding surface of molar teeth, both of the upper and lower jaws. Fig. 123 represents two views of an instrument having the general form of the one last described, but filed out on the under surface, the point being prominent; it is intended to be introduced a short distance into cavities in the posterior approximal surface of molar and bicuspid teeth. It is one which may be advantageously employed in many cases. Several sizes, both of this and the preceding one, are required, with slight modifications of form. The instrument represented in Fig. 124 is designed for intro-

Fig. 122. Fig. 123. Fig. 124.



ducing gold in cavities in the approximal surfaces of incisor and cuspid teeth, for which purpose it is peculiarly adapted.

The instruments represented in Fig. 125, contrived by Dr. Arthur, are said to be very useful in filling cavities in the approximal surfaces of teeth; judging from their appearance, we have no doubt they may be advantageously used in many cases. The instrument represented in Fig. 126, and of which several are required, varying in size and bent at different angles, is chiefly employed in filling cavities in the approximal surfaces. The working extremity is serrated. This is done in either of two ways. When one or two deep serrations are required, it is best done with a small, extremely fine, acute-angled file. When shallow serrations, or a number of them (made either in only one direction or cross-cut), are required, take a flat single-cut file, more or less fine, according to the size of the serrations wanted; pass the point of the plugger eight or ten times, with a steady movement, across the file, in the direction of the cut. By turning the point and carrying it again across the file, at right-angles with the first cut, the surface is dentated with rows of sharp points. The extreme point of the instrument must then be made as hard as possible (pale straw color), short of brittleness; but beyond the point the temper may be more elastic and softer.

Fig. 125.

Fig. 126.

Instruments with their working extremities bent at various angles, and of different lengths and sizes, some reduced nearly to a sharp point, like those represented in Figs. 127, 128, are required in consolidating the gold in cavities of the grinding, approximal, and buccal surfaces. The points may be round or flat as the operator may prefer. Points, also, much smaller than the smallest here represented, bent at different angles, are needed.

Fig. 127.

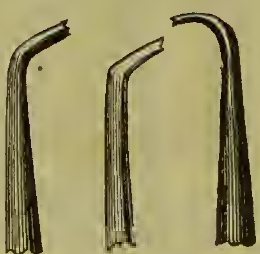


Fig. 128.

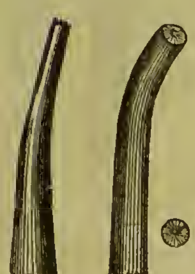
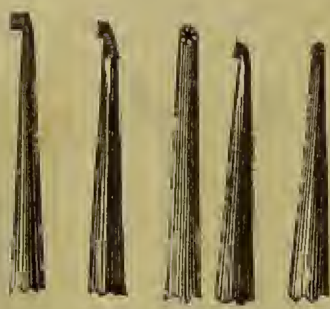


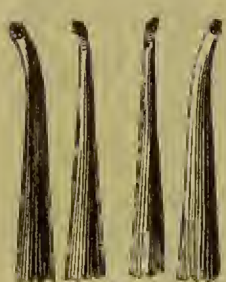
Fig. 129 represents another form of instrument used for introducing and partially compressing gold in approximal cavities. The working extremities, as seen in the cut, forming a right-angle with the stem of the instrument, should vary in length and diameter, from the largest here figured, to the most delicate dimensions, so as to be made available in the various cases in which their use may be required.

Fig. 129.



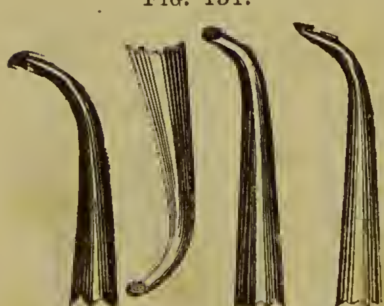
Another instrument with working points somewhat like those shown in Fig. 129, but with a curved stem, is represented in Fig. 130. When bent in this way, they are made in pairs, one for the right and one for the left side, and should be of different sizes. For introducing and partially condensing gold in approximal cavities in the molar and bicuspid teeth, they are peculiarly well adapted. The author has a set made from patterns prepared by Dr. Ballard, of New York, which, for this purpose, he has found more serviceable than any other description of instrument.

Fig. 130.



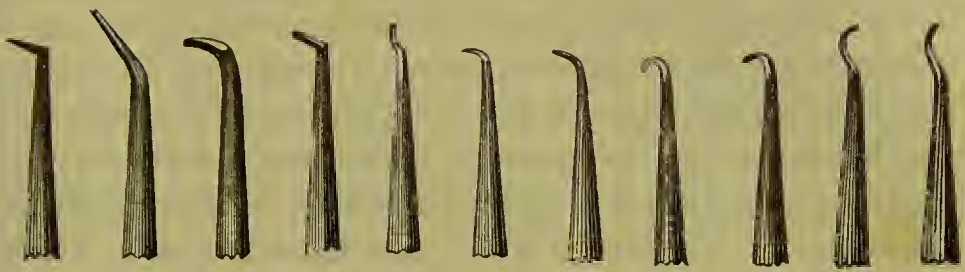
The instruments in Fig. 131 are used in introducing and partially compressing gold in anterior and posterior approximal cavities of molar and bicuspid teeth. Instruments of this description have been used by dentists for many years for condensing gold foil; but they may be employed more advantageously in working crystalline gold. It is only, however, in the earlier stages of the operation that they can be efficiently used, unless the working extremity be very small.

Fig. 131.



In Figs. 132, 133 and 134 instruments with variously shaped points are represented. Some of them are mere modifications of those previously described. But in the use of crystalline and sponge gold they will all be found very useful.

Fig. 132. Fig. 133. Fig. 134.



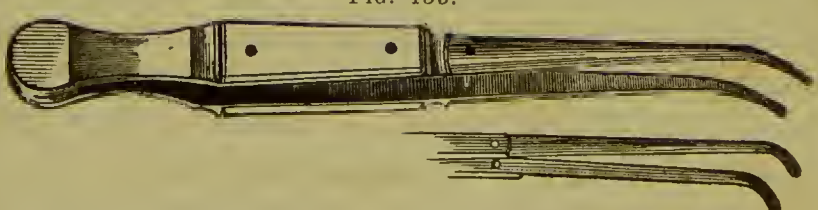
Other forms of instruments are sometimes employed in the use of sponge gold, but those here represented will be found amply sufficient for all operations, and hence it has not been deemed necessary to give a more extended description.

INTRODUCING AND CONSOLIDATING THE GOLD.

In filling teeth with crystal or sponge gold, the cavity in the tooth is prepared in the same manner as when leaf gold is employed. This done, the gold is cut, or rather torn with the point of an instrument, into small pieces, varying in size according to the dimensions of the cavity and the particular stage of the operation in which it is to be used. It being important that the crystals or particles composing the mass, should be as little separated or displaced as possible, before the piece is carried to its place in the tooth; it should be used in pellets as large as can be introduced into the cavity without crumbling.

The gold being divided into pieces of the proper size, the cavity is washed, and then wiped dry with prepared cotton, flax or bibulous paper; a piece of gold, as large as the orifice of the cavity will receive, is taken up with suitable pliers (Fig. 135) or

Fig. 135.



one of the instruments represented in Figs. 120, 121, as may be most convenient. The spongy mass readily adheres to the serrated surface of the working extremity, when pressed gently upon it, and with this it may, in most cases, be carried to the bottom

of the cavity. Every part must now be thoroughly consolidated, first with a large, and next with a smaller, and lastly with a very delicately pointed instrument, so bent that it may be readily applied to all the depressions and inequalities of the walls and floor of the cavity; for unless the gold is made absolutely solid in these places, as well as throughout all the parts of the filling, the success of the operation will be more or less uncertain. Thus, piece after piece is applied, consolidating each one as the operation progresses, until the gold protrudes sufficiently from the orifice of the cavity to admit of a good finish, leaving the surface flush with that of the tooth.

If, during any part of the operation, the smaller pointed instruments can be forced between the gold and the walls of the cavity, such opening or openings should be filled with smaller masses of the material before another large piece is introduced. This precaution ought never to be neglected, for should any soft places exist after the completion of the operation, the filling will be liable to absorb moisture and ultimately to crumble and come out. It is also indispensably necessary that the gold, during its introduction into the tooth, be kept absolutely free from moisture, as this destroys the adhesive or welding property of the crystals.

The gold having been introduced and consolidated as directed, the exposed surface is scraped or filed down to a level with the orifice of the cavity, then made smooth by rubbing it with Arkansas stone, or with finely powdered pumice, and burnished or polished with crocus, in the manner as described when gold foil is used.

In finishing a filling made with these preparations of gold, the operator should see that there are no thin overlapping portions upon the teeth outside of the orifice of the cavity. They are liable, in biting hard substances, or in ordinary mastication, to be broken off, leaving a depression for the lodgment of extraneous matter and clammy secretions. Sooner or later this will give rise to a softening of the dentine thus exposed, which, if it does not cause the filling to loosen, will ultimately render its removal and replacement necessary. In short, the precautions necessary to be observed in making a filling with gold foil are equally necessary when the operation is made with either of the preparations now under consideration.

We might enlarge upon this part of our subject, by going into detail and describing the various manipulations required to fill a tooth in the several localities in which the operation may be called for; but the foregoing general directions will serve as a sufficient guide to the dentist in the use of these preparations of gold. For a fuller exposition of the subject, the reader is referred to a series of interesting articles by Dr. C. W. Ballard, published in the March, April, May and June numbers for 1855, of the New York Dental Recorder, and to the article, by Dr. Dwinelle, previously referred to.

CHAPTER EIGHTH.

BUILDING ON THE WHOLE OR PART OF THE CROWN OF A TOOTH.

Few persons have the patience to undergo an operation requiring so much time for its performance, as the building on the whole, or a large part of the crown of a tooth, and fewer still are willing to incur the expense of the labor and gold necessary to make one. Hence, it is seldom attempted, and can only be performed by the most expert and skillful manipulators. Professor Austen, speaking of these operations, says: "The majority of them are a useless waste of the skill of the dentist, the money of the patient and the time of both. A molar fang that has its periosteum injured by the protracted and heavy pressure required in building up a golden crown is in far worse condition than if nothing had been done. If simply the canals and remaining part of the pulp-cavity had been filled, the root would present a condition analogous to those cases in which the crown is worn off (or, it may be, decayed off) and the pulp-cavity filled by ossific deposit: such roots render valuable service for many years. An incisor tooth which carries upon half or one-third of its surface a golden sign of dental craft, disfigures the patient; shows none of the *ars celare artem*, which should as far as possible characterize all dental work; and has a very questionable permanence or utility." Nevertheless, as these operations are sometimes done, it would not be proper to omit a description of the manner of doing them.

It is scarcely to be expected, however, that any one who has not had considerable experience in filling teeth, and acquired a high degree of dexterity in the use of instruments and the working of some one or more of the preparations of gold employed for the purpose, will, simply from any directions that can be laid down upon the subject, be able at once to perform the operation. But it is hoped, that the following description may serve as a

guide to those who have never attempted it and may wish to exercise their mechanical and artistic abilities on this, the most difficult of all operations in dentistry. Those only who are aiming at high excellence in this department of practice, will be likely to undertake it; and should their first efforts prove unsuccessful, the increase of skill they will have thus acquired in the use of instruments, will inspire new confidence, and ultimately, by perseverance, enable them to achieve the object of their wishes.

The operation to be successful must not only be performed in the most perfect manner, but the tooth itself must be situated in a healthy socket and firmly articulated. Under other circumstances it would be useless to attempt the restoration of the organ. The general system, too, should be free from any preternatural susceptibility to morbid impressions.

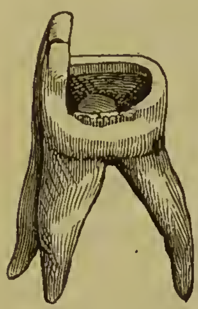
A tooth on which this operation is called for has, in nearly every case, suffered so much loss of substance as to involve exposure of the pulp; consequently the destruction and removal of this, is the first thing to be attended to; unless, as is sometimes the case, it has previously perished from inflammation and suppuration. Where this has happened, the permanent preservation of the organ cannot be counted on with as much certainty as when it is destroyed by the application of an escharotic two or three days before the performance of the operation. Its destruction by the suppurative process is more apt to be followed by alveolar abscess; and this having once established itself, is seldom so completely cured as to prevent the liability to its recurrence. Still, if the operation is determined on, the parts of the extremity of the root must first be restored to health; for without this it should never be attempted. The preparatory treatment in cases of this sort, as well as in cases of simple morbid secretion escaping from the fang, is given in another chapter.

In describing the operation, we will commence with the first molar of the left side of the superior maxilla. We will suppose that about three-fourths of the crown has been destroyed by caries, and that the buccal wall is the only portion remaining, the pulp being more or less exposed. This is to be destroyed and extirpated to the extremity of each root; the decayed portions of the tooth are then to be removed, and the central chamber enlarged until the wall of dentine on the palatine, anterior

and posterior approximal sides are only about one line in thickness. On the inside of this wall, a shallow groove or undercut is made to give additional security to the gold.

The tooth as now prepared is represented in Fig. 136, and is ready for the introduetion and building on of the gold. But before describing the manner of doing this, it may be well to say a few words with regard to the preparation of gold most proper to be employed. For filling the roots, the foil ordinarily used is the best. If the leaves are thick, weighing from fifteen to twenty grains, it should be introduced in very narrow strips, without folding, in the manner deseribed in another ehapter; if leaves of four or six grains are preferred, it may be cut in strips varying from an eighth to a quarter of an ineh in width, according to the size of the eanal in the root, and then rolled or made into very narrow folds. For the eentral chamber and erown, gold possessing adhesive propertics should be employed; this property may be imparted to eommon gold foil by slightly annealing immediately before using; foil made from erystalline gold possesses it in a higher degree, but this also requires to be annealed. Either kind of foil, therefore, or erystalline gold itself may be employed. The operation, however, ean be made with less labor with either of the first two, than with the last named preparation.

Fig. 136.



The manner of filling roots having been before deseribed, we shall eommenee with the pulp-eavity. The gold, supposing it to be foil No. 4, is eut, eaeh leaf into four or six pieees, which are loosely rolled into round or oval pellets. A suffieicnt number of these having been prepared, the surfaees against whieh the gold is to be plaeed are made perfeetly dry by wiping with bibulous paper, flax or eotton. This done, one of the pellets or balls is placed in the eentral ehamber with pliers, and partially consolidated with a small pointed condensing instrument; another and another is added, each being eonsolidated as the first; until a suffieient number have been introdueed to obtain so firm a support from the surrounding wall of dentine as to prevent any portion of the filling from being moved. The proeess of consolidation is now to be repeated and continued, until no part of the gold ean be

made to yield to the pressure of the instrument; then additional pellets are applied and condensed as in the first instance, until the pulp-cavity is completely filled; forcing those placed against the surrounding wall firmly and compactly into the groove or undercut made in it, thus securing for the entire mass the greatest possible stability. Again, pellet after pellet is applied, pressing those placed along the outer edge firmly against the exposed margin of dentine and against the buccal wall of the tooth; until a solid mass, considerably larger than the portion of the crown to be supplied shall have been thus formed.

For the complete solidification of every part of the gold, and the welding of every piece to the adjoining ones, a number of instruments are required, with serrated points, varying in size from the one in Fig. 110 to less than half the size of the one in Fig. 107. For some parts of the operation a straight instrument can be employed most advantageously; for other parts one slightly bent near the point, and for others one bent at right angles with the stem: the kind most suitable for each case must be determined by the judgment of the operator. One, perhaps, may use very efficiently an instrument in a particular locality and for a certain purpose, that another for the same purpose would handle very awkwardly. But for completing the work of consolidation, all agree that very small pointed instruments are indispensable.

As the adhesiveness of the gold is destroyed by the contact of liquids, it must be kept absolutely free from moisture during the entire process of introducing and consolidating the metal. But if, notwithstanding every precaution, the saliva should come in contact with the gold before its complete introduction, the unfinished surface must be thoroughly consolidated; then dried with some good absorbing substance, scraped, burnished, dried again, and made rough with a sharp pointed instrument. To this surface fresh portions of gold can now be united, and made to adhere as firmly as if no interruption had taken place.

The next step is to consolidate thoroughly every part of the surface. This may be commenced with the larger pointed instruments. After going over it ten or a dozen times with these, smaller points may be used, and these again changed for still

smaller, until no more impression can be made upon it than upon a solid ingot of pure gold.

It now remains to file and scrape the surface until the gold is made to assume very nearly the shape of that portion of the original tooth, the loss of which it supplies. In doing this an opportunity is afforded to the operator for the display of much artistic skill and ingenuity. While shaping the grinding surface, the patient should be requested from time to time to close the mouth; that the depressions in it may be made to correspond to the cusps of the tooth with which it antagonizes, so that these two may touch simultaneously with the other teeth of the upper and lower jaws. This part of the operation is always tedious, usually requiring more time than for the consolidation of the gold.

The surface of the gold may now be rubbed with properly-shaped pieces of Arkansas or Lake Superior stone, or with pulverized pumice, until all the scratches left by the file are removed; then polished with crocus or a burnisher. The appearance of the tooth as thus restored is shown in Fig. 137.

Fig. 137.

As it is impossible to perform the entire operation at one time, it may readily be divided into three parts. The *first* consisting in the extirpation of the pulp and the preparation of the tooth; the *second*, in the introduction and solidification of the gold; the *third*, in giving to the metal the proper conformation and in finishing the surface. The time required for the first, supposing the operation to be like the one just described, may vary from one and a half to two and a half hours; for the second, from two to three and a half hours, and for the third, from two to six hours—according to the difficulties to be encountered, the ability of the dentist, and the completeness of his preparation for the operation. Some, perhaps, may prefer crystalline or sponge gold, supposing it to be more easily welded than adhesive foil; but as the manner of working this variety of gold has already been dsecribed, it will not be necessary to give additional directions for its use.

The operation of building on the entire crown of a tooth should be proceeded with in much the same way as just described

for part of the crown. If too large pieces of either crystal gold or foil are used at one time, the surface will become crusted over by the pressure of the point of the instrument, and this will prevent, by any subsequent force that can be safely applied, its thorough consolidation. In this case, the general mass will be more or less spongy and the operation imperfect. The dentist should be well assured, therefore, as he progresses with his work, that every successive layer is firmly adherent to the preceding one. To build up an entire crown requires more time; perhaps, also, more skill, as there is no wall of tooth substance to give partial support. In other respects it resembles the previous operation.

It has been suggested by Professor Austen, as a plan to avoid much of the tediousness of the second stage of this operation, to fill the pulp-cavity, enclosing in the centre a screw-cut, notched, or double-headed pin, and carrying the gold over the edges of the cavity; make this surface somewhat irregular in shape, but finish it smoothly and trim the circumference to the exact size of the tooth; take a wax or plaster impression of the surface, and fit to the plaster model a lump of gold, having in the centre a hole larger than the pin projecting from the root; shape and polish it *out* of the mouth, then set it in place and secure it by filling with gold around the pin. If the color is not objected to, a vulcanite crown could be very perfectly adapted in this manner; or a porcelain tooth could be made, hollow in the centre, with pins or a dovetail to hold a thin layer of vulcanite, by means of which it could be fitted with perfect accuracy to the prepared root. Professor Austen thinks that in this way the root will be less injured, and the union between the gold and the root less disturbed than by the long-continued and severe pressure of the ordinary operation. While the artificial crown is being made, he suggests a temporary gutta-percha crown to prevent any irritation from the projecting pin.

A large portion of the crown of a tooth may be built up with ordinary gold foil, if it be of the best quality; but the adhesive preparations, either foil or crystal gold, are preferable. It is more difficult to build up the crown of a tooth in the lower than in the upper jaw, owing to the great difficulty of controlling the flow of saliva during so long an operation.

We have endeavored, in the foregoing description, to point out the general method of procedure in the operation of which we have been treating. We have also noticed some of the precautions necessary to be observed; but unexpected difficulties are sometimes encountered, the peculiar nature of which it is impossible to anticipate. Few, however, are of so formidable a character that they cannot be overcome. "Only," says Professor Austen, "let the operator assure himself that he is laboring for the real benefit of his patient, and not degrading his art: on the one hand, by humoring an idle whim of his patient; or, on the other, by making him the reluctant advertising medium of dental ingenuity."

CHAPTER NINTH.

TOOTH-ACHE.

PAIN in a tooth, tooth-ache, or *odontalgia*, as it is technically termed, is a symptom of some functional or structural disturbance; either of the organ in which the pain is seated, or of some other part or parts of the body, but more frequently of the former than of the latter. So variable is the character of the sensation, that any description would fail to convey, to one who has never experienced it, a correct idea of its nature. The pain sometimes amounts only to slight uneasiness; at other times the agony is almost insupportable. It may be dull, deep-seated, boring, throbbing, or lancinating. It may be slight at first, gradually increasing in severity until it amounts to the most excruciating torture, or it may come on without any premonition whatever. It may be confined to a single tooth, or it may affect several at the same time. It may commence in one tooth, and pass from thence to another, and continue until every one in turn has been attacked. It may continue for hours and days with scarcely any cessation; or it may be intermittent, the paroxysms recurring at stated or irregular intervals, and each lasting from thirty minutes to one, two, or more hours.

CAUSES.

The causes of tooth-ache are almost as numerous as are the varieties of character which it exhibits. Irritation and inflammation of the pulp, and inflammation of the investing membrane are among the most frequent; but it is sometimes referable to a morbid condition of the nerve or nerves going to a single tooth, or of the trunk from which several teeth are supplied; also to derangement of the digestive organs, to increased nervous susceptibility of the uterus resulting from pregnancy, amenorrhœa, &c., and to certain diatheses of the general system.

Dr. Hullihen enumerates the following as the causes of tooth-ache: 1, exposure of the nerve; 2, fungus of the nerve; 3, confinement of pus in the internal cavity; 4, a diseased state of the periosteum covering the fang; and 5, sympathy. Dr. Heilden attributes it to congestion or inflammation, or to a lesion of the nerves of the lining membrane and pulp, or of the peridental membrane.

Inflammation of the lining membrane and pulp may be produced by a blow upon a tooth, or by powerful impressions of heat and cold communicated through the enamel and dentine, or through a metallic filling; but it is more frequently occasioned by pressure, or by the direct contact of irritating agents, such as carious portions of the tooth, particles of food, acrid humors, and other irritating external substances. But inflammation is not always a necessary consequence of such impressions. Pain may be produced by them when inflammation does not exist; in this case it usually subsides soon after the removal of the irritant. Indeed, the pulp of a tooth may be exposed for months, and subjected several times every day to the contact of foreign substances, without becoming the seat of inflammatory action; and in the absence of this, the pain, though coming on with the suddenness of an electric flash, and often of the most excruciating kind, is seldom of long duration.

But when inflammation exists, the pain, which at first amounts only to a slight gnawing sensation, is more constant; after a while, it assumes a throbbing character, and if not promptly arrested, it increases in severity, and continues until suppuration of the lining membrane and pulp takes place. So long as it is confined to the parts within the pulp-cavity, the pain is not increased by pressure on the tooth; nor is the tooth started from the socket, as in periodontitis. The locality of the inflammation may also be distinguished by the fact, that cold water or ice applied to the tooth generally gives relief. But the inflammation rarely confines itself long to the interior of the tooth; it usually soon extends to the periosteum of the root and its socket, when a somewhat different train of phenomena are developed. Suppuration, however, having taken place, an abscess soon forms at the extremity of the root.

The severity of the pain attending *odontitis*, (as inflammation

of the pulp is technically termed, from the supposition that every part of the organ is involved in the diseased action,) is, doubtless, owing to the fact that this exceedingly sensitive structure, as its vessels become injected, is prevented from expanding by the unyielding nature of the walls of the cavity in which it is situated. Its capillaries being thus distended, must, as a necessary consequence, press upon the nerves which are everywhere distributed through it, and the excruciatingly painful throbbing sensation, by which this variety of tooth-ache is characterized, is produced by the pulsation of these vessels. Hence, increased action of the heart and arteries, from whatever cause produced, augments the pain; it is also more severe at night, while the body is in a recumbent posture, than during the day, because this position gives an increased fullness to the arteries of the head. The phenomena attending the inflammation, however, are influenced very much by the condition of the tooth and the habit of body of the patient.

When the inflammation is acute, it extends to every part of the pulp and lining membrane. It also occurs more frequently before than after these tissues have become exposed, and generally terminates in suppuration. Chronic inflammation usually arises from partial exposure of the pulp, and may exist for months without being attended with pain; but the pulp, when thus affected, is more susceptible of injury by heat or cold, and by irritating substances; and the liability of the tooth to ache, especially at night, is greatly increased.

Tooth-ache caused by acute inflammation of the investing membrane, is characterized by pain, at first dull, afterwards acute and throbbing, soreness and elongation of the tooth, redness and tumefaction of the gums, and sometimes by swelling of the cheek; indicating the formation of alveolar abscess. In this variety of odontalgia, the tooth is often so much raised in its socket as to interfere more or less with mastication.

The pain attending the foregoing pathological conditions, when severe and protracted, is often accompanied by constipation, head-ache, dryness of the skin, flushed cheeks, fullness and increased rapidity of pulse, and other constitutional symptoms.

The nervous susceptibility of the teeth is sometimes so much

increased by organic and even functional disturbances of other and often remote parts, that the mere contact of the minute nerves of the pulp and lining membrane against the wall of dentine which encases them, is attended with severe pain. This variety of odontalgia is termed *sympathetic*, and is supposed to be the result of the transfer of nervous irritation, or more properly of *exalted sensibility* of the dental nerves, arising from a morbid condition or functional disturbance of some other part. If this hypothesis be true, it is probable that with this heightened nervous excitability there is a slight increase of vascular action in the pulp, with a corresponding increase of size in its capillaries; in consequence of which, it is fair to presume, the nervous filaments supplying these tissues would be apt to respond painfully to the undue pressure. Though pain, arising from this cause, may have its seat in sound as well as in decayed teeth, it occurs more frequently in the latter than the former, owing to the fact that any structural alteration in the dentine adds to their already increased nervous excitability.

Persons of highly excitable nervous temperaments, pregnant females, and individuals laboring under derangement of the digestive organs are particularly subject to this variety of tooth-ache. Odontalgia arising from pathological conditions or functional disturbances of other parts, assumes a great variety of forms. The pain may be continued, but more frequently it is periodical; it may be confined to a single tooth, or it may attack half a dozen or more at the same time. It sometimes also alternates with the paroxysms of rheumatism or gout, the pain in such cases assuming the specific character of these diseases.

Mr. W., aged 40, for fifteen years the victim of gout, came to me in 1830. The first right upper molar was carious, but the pulp not exposed. Ten or twelve days before each attack of gout, recurring every three or six months during the last five years, this tooth was the seat of a peculiar grinding, lancinating pain; becoming gradually more severe, but ceasing entirely as the gout symptoms came on, it returned as these subsided, and continued for two weeks. Filling the tooth gave temporary relief only, and it was found necessary to extract it.

In what is termed neuralgic tooth-ache, "the pain," says Dr.

Wood, "is usually of the acute character; sometimes mild in the beginning, gradually increasing in intensity, and as gradually declining, but usually very irregular; at one time moderate, at another severe, and occasionally darting with excruciating violence through the dental arches. Not unfrequently it assumes a regular intermittent form. Instead of pain, strictly speaking, the sensation is sometimes of that kind which is indicated when we say that the teeth are on edge, and is apt to be excited by certain harsh sounds, such as that produced in the filing of a saw or by mental inquietude, and by the contact of acids or other irritant substances. Neuralgic tooth-ache sometimes persists, with intervals of exemption, for a great length of time. The diagnosis is occasionally difficult. When, however, it occurs in sound teeth, is paroxysmal in its character, is attended with little or no swelling of the external parts, occupies a considerable portion of the jaw; and especially when it alternates or is associated with pain of the same character in other parts of the face, there can be little doubt as to its real nature." This variety of sympathetic tooth-ache is perhaps induced by caries, or by the manner in which the teeth are arranged in the alveolar arch, or by some peculiar susceptibility of the parts; as is shown by the fact, that the pain usually ceases on the removal of all such causes of irritation.

But while, on the one hand, pain in the teeth may be caused by a morbid condition of other organs, these organs, on the other hand, frequently sympathize with the diseased condition of the teeth, and become, to quote the language of Mr. Bell, "the apparent seat of pain. I have seen this occur not only in the face, over the scalp, in the ear, and underneath the lower jaw; but down the neck, over the shoulder, and along the whole length of the arm." Cases of this sort are frequently met with.

In treating of tooth-ache, Dr. Good observes: "This is often an idiopathic affection, dependent upon a peculiar irritability (from a cause we cannot easily trace) of the nerves subservient to the aching tooth, or of the tunics by which it is covered, or of the periosteum, or the fine membrane that lines the interior of the alveoli. But it is more frequently a disease of sympathy, produced by pregnancy, or chronic rheumatism, or acrimony

in the stomach, in persons of an irritable habit. It is still less to be wondered at, that the nerves of the teeth should often associate in the maddening pain of facial neuralgia, or tic douloureux, as the French writers sometimes term it; for here the connection is both direct and immediate. In consequence of this, the patient, in most instances, regards the teeth themselves as the salient points of pain, (as they unquestionably may be in some cases,) and rests his only hope of relief upon extraction; but when he applies to the operator, he is at a loss to fix upon any particular tooth. Mr. Fox gives a striking example of this, in a person from whom he extracted a stump which afforded little or no relief; in consequence of which his patient applied to him only two days afterward and requested the removal of several adjoining teeth, which were perfectly sound. This he objected to, and suspecting the real nature of the disease, he immediately took him to Sir Astley Cooper, who, by dividing the affected nerve, produced a radical cure in a few days." The author is acquainted with a gentleman similarly affected. He has had all his teeth on the right side of both jaws extracted, without obtaining any relief.

There is still another cause of tooth-ache, which we should not omit to mention—exostosis; but from the obscurity of the diagnosis, the existence of the affection can seldom be determined with positive certainty, except by the removal of the tooth. As we shall hereafter have occasion to treat of this disease, it is unnecessary in this place to dwell upon the subject.

Finally, some teeth, from peculiar constitutional idiosyncrasy, are more liable to odontalgia than others. It sometimes happens that every tooth in the mouth is destroyed by caries without being affected with pain, while at other times, teeth apparently sound become the seat of the most agonizing torture.

TREATMENT.

The first thing to be attended to in the treatment of tooth-ache is the removal of the causes which have given rise to it; this can only be done by carrying out the curative and remedial indications of the morbid conditions and functional disturbances with which it is connected. While these continue, it will be im-

possible to obtain permanent relief. The sensibility of the nerves supplying a tooth may often be obtunded, and the pain palliated by the application of stimulating and anodyne agents to the exposed pulp; but the relief thus procured is seldom of long duration. When their effects subside, the pain usually returns with increased severity. When the pain arises from chronic inflammation and irritation, produced by external agents on an exposed portion of the lining membrane, such applications may often be employed with great advantage; and among those which have been used for this purpose are creosote, the oil of cloves, cinnamon, etc.; laudanum, spirits of camphor, tannin, ether and chloroform. But of all the remedies prescribed by the author, he has found none more useful in allaying the pain than the following:

Sulphuric æther,	℥i.	Sulphuric æther,	℥i.
Powdered camph.,	ʒij.	Creosote,	ʒss.
Powdered alum,	ʒij.	Ext. of nut-galls,	ʒi.
Sulphate of morphia,	grs. ij.	Powdered camph.	ʒss.

The alum should be very finely powdered, and all the ingredients well mixed before use.

After removing all foreign matter and carefully drying the cavity of the tooth, a small bit of cotton or lint dipped in either of the above mixtures may be applied, and renewed several times a day if necessary. The relief obtained is, in the majority of cases, almost instantaneous; but as the effect is only temporary, the pain is apt to recur. The author has sometimes used a thick solution of *gutta-percha* in chloroform. The application of a drop or two of this to the exposed pulp is usually followed by the immediate cessation of pain, and as the chloroform evaporates, a thin layer of gutta-percha remains and serves for a time as a sort of protection to the pulp.

But the only way in which permanent exemption from pain can be procured is, by the extraction of the tooth or the destruction of the pulp; it often becomes necessary to have recourse to the latter, as there are many cases in which the patient cannot be prevailed upon to submit to the former, and as there are others in which the retention of the organ is called for by some peculiar necessity. This may be effected either by immediate extirpation with a small sharp-pointed elastic stilet or probe, by

the actual cautery, arsenious acid,* cobalt, or chloride of zinc. Immediate extirpation, arsenic, or cobalt are the means usually employed for the purpose; but we have already described the manner in which the destruction of the pulp is effected by each of these.

Pain in a tooth arising from acute inflammation of the pulp and lining membrane, can only be relieved by the extraction of the tooth, the destruction of the pulp, or by subduing the inflammatory action; the last can seldom be done except by the most energetic treatment in the very beginning in cases where the decay has not penetrated to the pulp-cavity. The propriety or impropriety of extraction will be determined by the amount of pain, the progress made by the inflammation, the condition of the parts with which the tooth is immediately connected, the effect of the local disturbance upon the general system, the situation and importance of the tooth, and the extent of structural alteration which has taken place in the crown. If the retention of the tooth, on account of its location, or the loss of several other teeth, is of great importance to the patient; and the circumstances of the case justify a well-grounded belief that it can be preserved and rendered useful, without acting as a morbid irritant, the operation, if possible, should be avoided. In this case, supposing the inflammation to have proceeded too far to be arrested, the pulp may be destroyed and the tooth treated in the manner described in another chapter; as it would be useless to prolong the suffering of the patient by attempting any other treatment in the vain hope of securing the permanent preservation of the organ. Indeed, after the lining membrane has become exposed, removal of the pulp is the only method which, in any stage of the inflammation, holds out a fair prospect of success.

When the inflammation is produced by other causes than exposure of the pulp and the contact of external irritants, it may, perhaps, be successfully combated. The treatment is similar to that for local inflammation in other parts of the body; the

* The employment of arsenious acid for the destruction of an exposed dental pulp, and the relief of the pain arising therefrom, originated with the late Dr. Spooner, of Montreal, and in 1835 it was recommended to the profession by his brother, Dr. S. Spooner, of New York, in an excellent popular treatise upon the teeth.

administration of saline cathartics, the application of leeches to the gum of the affected tooth, abstinence from animal food and from stimulating drinks. If the pulse is full and hard, blood may be taken from the arm with advantage. Should these means fail to arrest the inflammation, and suppuration take place, the formation of alveolar abscess may be prevented by promptly perforating the crown of the tooth for the escape of the matter; but such cases usually terminate in periodontitis, which, perhaps, arise as frequently from this as from any other cause.

The treatment of periodontitis or inflammation of the investing membrane is, for the most part, the same as above; in addition to which, the mouth may be gargled several times a day, with some cooling astringent wash. Fomentations to the face, and plasters of the seeds of hyoscyamus, mustard, capsicum, with various other narcotic or rubefacient applications have sometimes been found useful. But when the formation of alveolar abscess is threatened, the removal of the tooth, in most cases, will be found necessary. If it be an incisor or cuspid, however, the operation should be performed as a last resort.

When the inflammation is chronic, the necessity for the removal of the tooth is still more urgent. But some eminent practitioners give us accounts of the successful treatment of chronic abscess in teeth which have been filled to the extremity of the fang. Through the fistulous opening of the abscess, or through an artificial opening in the alveolus opposite the end of the fang, nitrate of silver is introduced; it is used either in strong solution or a minute quantity of the solid nitrate is applied. Its application should be continued at intervals of several days until the chronic diseased action is overruled.

Tooth-ache assuming a rheumatic or gouty character calls for a somewhat different plan of treatment. In addition to the local means already described, it may be necessary to adopt the constitutional treatment applicable to rheumatism and gout. When the pain arises from increased vascular action and nervous irritation of the pulp, occasioned by a disordered condition of the digestive organs, and assumes an intermittent form, an emetic or cathartic, followed by the use of quinine, will generally afford relief, provided caries has not penetrated to the pulp-cavity. If

dependent on general nervous irritability of the system, tonics, exercise, change of air, or such other constitutional measures as the peculiarities of the case may indicate, should be recommended.

The extraction of the tooth is the only remedy that can be relied upon for relief of pain arising from exostosis of the root. Dr. Good, however, thinks it may be cured in the early stages by the use of leeches and mercurial ointment.

CHAPTER TENTH.

EXTRACTION OF TEETH.

There are few operations in surgery that excite stronger feelings of dread, and to which most persons submit with more reluctance, than the extraction of a tooth. Many endure the tortures of tooth-ache for weeks and even months rather than undergo the operation; and, indeed, when we take into consideration the frequent accidents occurring in its performance by awkward and unskillful individuals, it is not surprising that it should be approached with apprehension. But when performed by a skillful hand and with a suitable instrument, the operation is always safe, and in a large majority of the cases may be effected with ease.

Dr. Fitch relates a case which will serve to illustrate the above remarks. The subject, a resident of Botetourt county, Va., in having the second right superior molar extracted by a blacksmith, had a large portion of the jaw and five other teeth removed at the same time. "The fangs of his tooth," says Dr. Fitch, "were greatly bifurcated and dove-tailed into the jaw, and would not pass perpendicularly out, though a slight lateral motion would have moved them instantly. The jaw proved too weak to support the monstrous pull upon it, and gave way between the second and first molars, and with it came both the anterior and posterior plates of the antrum. The broken portion extended to the spongy bones of the nose, and terminated at the lower edge of the socket of the left front incisor, containing six sound teeth, namely, the first molar, the bicuspids, cuspid, and incisors of the right side—six in all. The soft parts were cut away with a knife. A severe hemorrhage ensued, but the patient soon recovered, though with excessive deformity of his face and mouth."

Dr. Cross, of North Carolina, related to the author in 1838 a case very similar to the one just quoted. The operator in this,

as in the other instance, was a blacksmith; in attempting to extract one of the superior molar teeth he brought away a piece of the jaw containing five other teeth, together with the floor of the antrum and its posterior and anterior walls.

We have adverted to these cases to show the impropriety and danger of entrusting the operation to individuals possessing neither knowledge of its principles nor skill in its performance. Injuries occasioned by the operations of such persons have frequently come under the immediate observation of the author, with whom it has always been a matter of surprise that an operation to which such universal repugnance is felt, should ever be confided to them.

The removal of a wrong tooth, or of two or three instead of one, are such common occurrences, that it were well if the precautions given by the illustrious Ambrose Paré were more generally observed. So fearful was he of injuring the adjacent teeth, that he always isolated the tooth to be extracted with a file before he attempted its removal. He regarded it as of the greatest importance that a person who extracted teeth should be expert in the use of his "tooth mullets; for unless he knows readily and cunningly how to use them, he can scarcely so carry himself, but that he will not force out three teeth at once." Although great improvements have been made since his time in the construction of extracting instruments, yet even now the accidents to which he alludes are of almost daily occurrence.

It is surprising that an operation so frequently called for should receive so little attention from medical practitioners, by whom, though not strictly belonging to their province, it must frequently be performed. This neglect can only be accounted for, by the too general prevalence of the idea, that little or no surgical skill is necessary to its performance. But every physician residing in the country, or where the services of a skillful dentist cannot always be commanded, should provide himself with the proper instruments and make himself acquainted with the manner of performing this operation.

INDICATIONS FOR THE EXTRACTION OF TEETH.

With regard to the indications that determine the propriety of extraction, the author does not deem it necessary to say much in this place, as they are fully pointed out in other parts of the work. It may be well, however, to briefly mention, in this connection, a few of the circumstances which call for the operation.

Beginning with the teeth of first dentition; it will be sufficient to state, that when a tooth of replacement is about to emerge from the gums, or has actually made its appearance, either before or behind the corresponding milk tooth, the latter should at once be removed; and when the aperture formed by the loss of this is so narrow as to prevent the former from acquiring its proper position, it may sometimes be necessary to extract an adjoining temporary tooth. For more explicit directions upon this subject, the reader is referred to the chapter on the management of second dentition. Alveolar abscess, necrosis of the walls of the alveolus, and pain in a temporary tooth, which cannot be cured by any of the usual remedies, may be regarded as indications which call for the operation.

The principal conditions which should determine the extraction of a permanent tooth, may be enumerated in the following order: First; when a molar, from the loss of its antagonizing tooth, or from other causes, has become partially displaced, or is a source of constant irritation to the surrounding parts.

Second; a constant discharge of fetid matter from the nerve-cavity, through a carious opening in the crown. There may, however, be circumstances which would justify a practitioner, in permitting or even advising the retention of such a tooth; as, for example, when the discharge of fetid matter is not very considerable; also, where the tooth is situated in the anterior part of the mouth, and cannot be securely replaced with an artificial substitute. The secretion of fetid matter may, in a few cases, by judicious treatment be arrested, the tooth preserved for many years by plugging; and so the morbid influence it would otherwise exert upon the surrounding parts, may be counteracted. But it is only in the fewest number of cases, under such circum-

stances, that so favorable a result can be secured. A front tooth should not be sacrificed unless called for by some very urgent necessity; neither should an upper incisor nor cuspid be permitted to remain in the mouth, if it exerts a manifestly morbid action upon the surrounding parts: for in this case the consequences resulting from its retention in the mouth may be worse than the loss of the tooth.

Third; a tooth which is the cause of alveolar abscess, should not, as a general rule, be permitted to remain: but, if it be an incisor or cuspid, and the discharge of matter through the gum is small, occurring only at long intervals, and, especially, if the organ cannot be securely replaced with an artificial substitute, it may be permitted to remain. But an incurable abscess in the socket of a bicuspid or molar, should be considered as a sufficient indication for the removal of the tooth.

Fourth; irregularity in the arrangement of the teeth, arising from disproportion between the size of the teeth and the size of the alveolar arch, usually requires for its correction the extraction of some one or more teeth. But with regard to the teeth most proper to be removed, the reader is referred to the chapter on irregularity; where he will find full directions for the management of such cases.

Fifth; all dead teeth and roots of teeth, and teeth which have become so much loosened from the destruction of their sockets as to be a constant source of disease to the adjacent parts; or teeth otherwise diseased, that are a cause of neuralgia of the face, disease of the maxillary sinus, dyspepsia, or any other local or constitutional disturbance; such teeth should, as a general rule, be extracted.

There are other indications which call for the extraction of teeth, but the foregoing are among the most common; they will be found sufficient, in most instances, to determine the propriety or impropriety of the operation. Cases are however continually presenting themselves, to which no fixed rules would be found applicable, and where an experienced judgment alone can determine the practice proper to be pursued.

In conclusion, it is scarcely necessary to say, that whenever a tooth can be restored to health, it should always be done; but tampering with such as cannot be rendered healthy and useful.

and which, by remaining in the mouth, exert a deleterious influence, not only upon the adjacent parts, but also upon the general health, cannot be too strongly deprecated.

INSTRUMENTS EMPLOYED IN THE OPERATION.

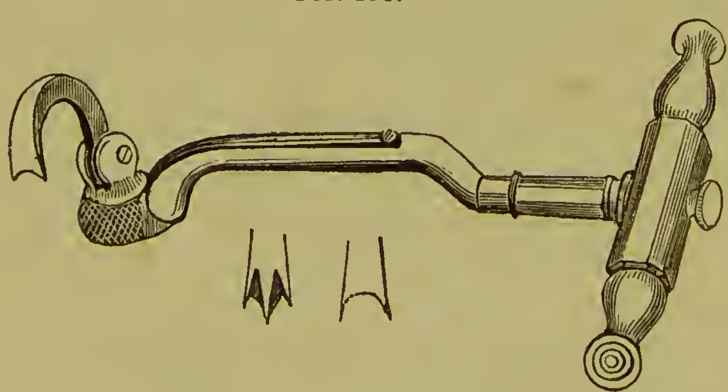
Different operators employ different instruments. For about fifty years, the key of *Garengeot* was almost the only instrument used in the performance of the operation; but this has in a great measure been superseded by forceps, which, when properly constructed, are far preferable; yet as the key is still used by some, and is doubtless in certain cases a valuable instrument, a brief description of it is here given.

KEY INSTRUMENT.

"The common tooth-key," says Dr. Arnot, "may be regarded in the light of a wheel and axle; the hand of the operator acting on two spokes of the wheel to move it, while the tooth is fixed to the axle by the claw, and is drawn out as the axle turns. The gum and alveolar process of the jaw form the support on which the axle rolls."

Different dentists have their keys differently constructed, but the principle upon which they all act is precisely the same. Some prefer the bent shaft, (Fig. 138) others the straight. Some

Fig. 138.



give a decided preference to the round fulcrum, others to the flat; and though the success of the operator depends greatly upon the perfection of the instrument, yet he may remove a tooth

more expertly by means of a key with which he is familiar, than one to which he is unaccustomed, though its construction be even better. Fig. 138 represents a key with bent shaft and two hooks, one for molars and the other for bicuspids.

The author has tried almost every variety of key instrument that has been used in this country, and thinks the straight shank with a small round fulcrum slightly flattened on each side, decidedly preferable to any other. The objection raised by some to the use of such a key, that it is liable to interfere with the front teeth, is without good foundation. It can be used with as much safety as a key of any construction, and in most cases can be as easily applied. The round is certainly preferable to the flat fulcrum, because it is less liable to injure the gums and the alveolus. In size it should be a little larger than a half-ounce bullet.

Every key instrument should be supplied with several hooks, differing in size, to suit the teeth upon which they are to be applied. The hook described by Dr. Maynard,* is preferable to any which the author has seen. It very nearly resembles the eagle's claw, except that its curvature is rather greater. The edge of the hook is about the sixteenth of an inch in width, and divided into two points, by a shallow notch. A hook of this description is less liable to slip, and can be more readily applied to a tooth than those ordinarily used.

With regard to the merits of the key instrument, or of any other instrument having the same principle of action, as compared with the forceps presently to be described, the author does not entertain a very high opinion. The following remarks quoted from the late work of M. Desirabode, accord with the views which he has held and promulgated for many years: "One of the most common causes of fracture of the alveoli is a badly performed operation in the mouth; although not a very flattering acknowledgment for our art, it is necessary to say it. If it be necessary to specify causes, we would not hesitate to name, in the first place, the use of the key of Garengeot; for we shall prove, in treating of the extraction of teeth, that this *dangerous* implement, which is only fit to mask the unskillfulness of the operator, is one of the most defective of surgical instruments;

* See Am. Jour. Dent. Sci. No. 3, vol. 3.

and no practitioner of good sense, being convinced of its mode of action, would attempt to use it even to extract a nail from a board, if he did not desire to break the surrounding material." Perhaps this condemnation is too sweeping. The principle of action of the key is in fact not unlike that of a nail-drawer, or tack-puller, and is well adapted to a certain class of cases: namely, where one wall, either the inner or outer, is decayed below the alveolus, while the opposite one is still standing. The fulcrum, with a folded napkin or other soft substance interposed, is placed against the gum on the side of the tooth most decayed, and the hook adjusted to the neck of the tooth on the opposite side.

MANNER OF USING THE KEY INSTRUMENT.

The directions required for the use of the key are few and simple; but, as cases frequently occur to which no general rules can be applied, much will depend on the practical judgment and surgical tact of the operator. The first step to be taken in the operation is to separate the gum from the neck of the tooth, down to the alveolus; this should be done, not on two sides only, but round the entire tooth. For this purpose, suitable lancets should be provided. A straight, narrow-bladed knife, pointed at the end, and with one cutting edge, will be found most convenient for performing the operation on the approximal sides; it may be most effectively used, by passing the point of the knife between the neck of the tooth and gum, down to the alveolus, with its back downward, then cutting in the direction of the crown. In this way, the connection of the gum to the sides of the neck of the tooth may be thoroughly severed. The same kind of knife or a common gum-lancet, may be used for separating the gum from the remaining sides of the tooth. If the gum is not well separated, there will be danger of lacerating it in the removal of the tooth.

After the tooth has been thus prepared, the key, with the proper hook attached, should be firmly fixed upon it; the fulcrum, on the inside, resting upon the edge of the alveolus, the extremity of the claw on the opposite side, pressed down upon the neck. The handle of the instrument is then grasped with the

right hand, and the tooth raised from its socket by a firm, steady rotation of the wrist. The claw should be pressed down with the fore-finger or thumb of the left hand of the operator, until, by the rotation of the instrument, it becomes securely fixed upon the tooth. This precaution is necessary to prevent it from slipping; an accident that frequently happens, and one that is always more or less embarrassing to the dentist.

If the tooth is situated on the left side of the mouth, the position of the operator should be at the right side of the patient; but, if it be on the right side, he should stand before him. For the removal of a tooth, on the left side of the lower jaw, or the right side in the upper, the palm of the hand should be beneath the handle of the instrument; in the extraction of one on the right side of the lower jaw, or on the left side in the upper, it should be above. The manner of grasping the instrument is of more importance than many suppose. If improperly held, the operator loses, to a great extent, his control over it.

The directions here given, are, in some respects, different from those laid down by other writers; but, we are convinced, from much experience, that they will be found more conducive to the convenience of the operator and the success of the operation than those usually given for the use of this instrumont.

There is a diversity of opinion, as to whether a tooth should be removed inwardly or outwardly. Some direct the fulcrum of the instrument to be placed to the outside of the tooth, others to the inside; while others, again, regard it as of little importance on which side it is placed. Experience has taught us that it should, in the majority of cases, be placed on the inside; especially of the lower teeth, as they almost always incline towards the interior of the mouth. Moreover, the edge of the alveolus is usually a little higher on the exterior edge of the jaw than on the interior; so, that the first motion of the instrument, with its fulcrum on the outside, brings the side of the tooth against its socket; thus, nearly double the amount of power is required to remove it; while, at the same time, the pain and the chances of injury to the alveolar processes are very much increased.

It is, however, frequently necessary to place the bolster of the key on the outside of the tooth; when, for instance, it is decayed in such a way as not to afford a sufficiently firm support for the

claw of the instrument. But, whenever it is possible to remove a tooth inwardly, it should be done. The alveolar walls of the upper teeth are, generally, thinner than those of the lower, and do not afford so strong a support to the fulcrum of the instrument.

FORCEPS.

Forceps were not very generally or extensively employed, except for the extraction of the front teeth, until about the year 1830, but the improvements made in their construction since that period are so great, that their use has now, among dentists, almost superseded that of the key.

The forceps formerly used were so awkwardly shaped, and so badly adapted to the teeth, that the extraction of a large molar with an instrument of this description, was regarded as exceedingly difficult, and even dangerous; even its practicability was doubted by many of the most experienced practitioners, and hence, the key was almost the only instrument resorted to for the purpose.

When we consider the strong prejudice that so recently existed against the use of forceps, it is not at all wonderful that their employment should have been resorted to with caution. Nor is it surprising that a gentleman of Mr. Bell's intelligence and practical experience, should, so late as the period of the publication of his work, 1830, tell us that the key is the only instrument to be relied upon for the removal of teeth that are much decayed; and that those who have heaped the most opprobrium upon it, are glad to have a concealed recourse to its aid.

This may have been true at the time Mr. B. wrote, but not now. On the contrary, cases are daily occurring of the extraction of teeth with forceps, upon which the key had been previously unsuccessfully employed. It is generally supposed that a greater amount of force is necessary to remove a tooth with forceps than with the key, but this is a mistake. It does not ordinarily require as much. The leverage gained by the action of the key is more than counterbalanced by the greater amount of resistance encountered in the lateral direction of the force exerted in the removal of the tooth by that instrument. But with forceps, the direction of the power being in the line of the

axis of the tooth, an amount sufficient to break up the connection with the socket, and to overcome the resistance of the walls of the alveolus is all that is required.

The author has used forceps exclusively since 1834, and he does not hesitate to affirm, that any tooth can be extracted with them that can be removed with the key; and that, too, in the majority of cases, with greater ease to the operator and less pain to the patient. He knows that in this expression of opinion, he differs from many of his professional brethren; and that there are many skillful and experienced practitioners, who, while preferring forceps for the extraction of most teeth, occasionally use the key. But he is confident that, if they would provide themselves with forceps properly constructed for the extraction of those teeth which they now remove with the key, and use them for six months to the exclusion of that instrument, they would never again return to its employment.

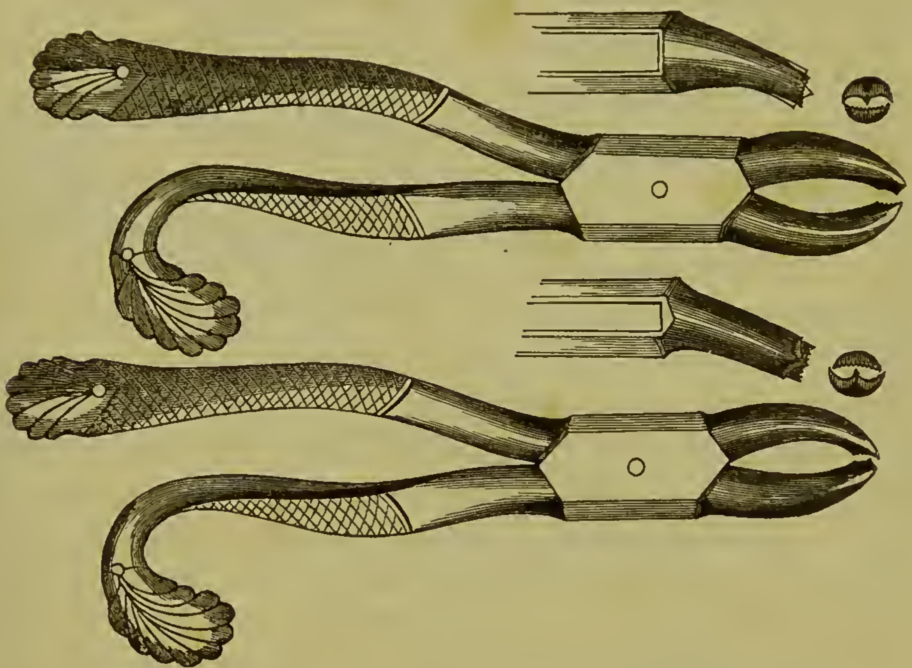
It may, perhaps, require a little more practice to become skilled in the use of forceps than in that of the key. We would, therefore, advise those who have been accustomed to the latter, not to lay it at once entirely aside; but to commence the use of forceps on teeth that are least difficult to remove, as, for example, the bicuspids, and afterward upon the molars.

In order that forceps may be used with ease, it is necessary they should be properly constructed. Every operator should possess several pairs, (seven at least,) each with a differently-shaped beak, adapted to the necks of the teeth to which they are respectively designed to be applied.

For the extraction of molars, the forceps recommended by Mr. Snell are the best in use. His improvements, made in the shape of the beaks of the upper and lower molar forceps, are very valuable; to which he is entitled to much more credit than the profession generally have accorded. For the upper molars two (Fig. 139) are required, one for each side, curved just below the joint, so that the beak shall form an angle of twenty or twenty-five degrees with the handles, just enough to clear the lower teeth. The inner blade is grooved to fit the neck of the palatine root; the outer blade has two grooves, with a point in the centre to fit the depression just below the bifurcation of the two buccal roots. Another valuable improvement of his consists

in having one of the handles bent so as to form a hook. This passes round the operator's little finger, to prevent the hand from slipping.

FIG. 139.



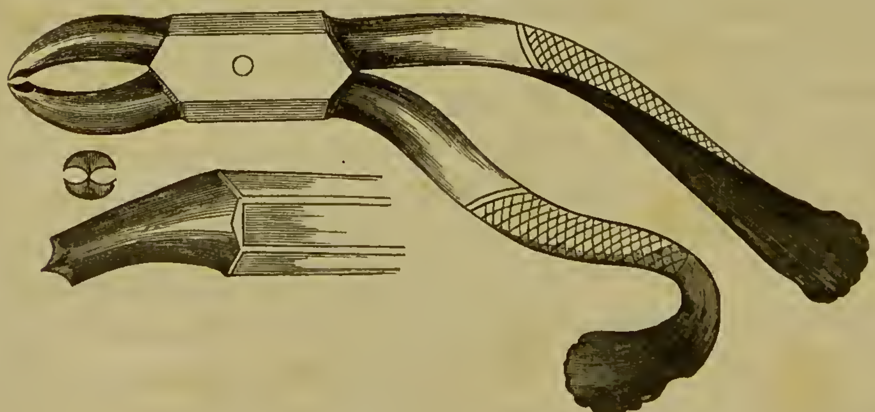
In the drawings which Mr. Snell has given of his upper molar forceps, the hook is on the palatine handle of each; so that in the extraction of a right upper molar, the upper side of the instrument must be grasped, and the lower side in the extraction of a left upper molar. But the author has found that they can be more conveniently employed by having the handle so bent, that when applied, the hook of each is next the operator. (Fig. 139.) The handles should be wide, and large enough to prevent them from springing under the grasp of the hand, to which they should be accurately fitted. Every dentist, therefore, in having forceps manufactured, should give special directions with regard to their shape and size. The beak should be bent no more than is absolutely necessary to prevent the handles from coming in contact with the teeth of the lower jaw; for in proportion to the degree of curvature will the muscular power of the operator be disadvantageously exerted.

Each blade of the beak of the lower molar forceps has two grooves, with a point in the centre, so situated that in grasping the tooth it comes between the two roots just at the bifurca-

tion. Mr. Snell employs two pairs for the extraction of the lower, as well as for the upper molars, in order, as he says, to have a hook to turn round the little finger, which he supposes must be on opposite sides of the instrument. But this is rendered unnecessary by an improvement made by the author in 1833; which consists in having the handles of the instrument so bent that it may be as readily applied to one side of the mouth as the other, while the operator occupies a position to the right and a little behind the patient. By this improvement, the necessity for two pairs is wholly superseded; it moreover enables him to control the head of the patient with his left arm, and the lower jaw with his left hand, rendering the aid of an assistant wholly unnecessary.

The shape of the instrument, as improved by the author, is shown in Fig. 140. It is now used by many hundreds of operators, who prefer it to any other instrument they have ever employed. When applied to a tooth, the handles turn toward the operator, at an angle of about twenty-five or thirty degrees. Without this curvature in the handles, the arm of the operator would often be thrown so far from his body as to prevent the proper control over the instrument. It is also important that the handles should be wide and accurately fitted to the hand.

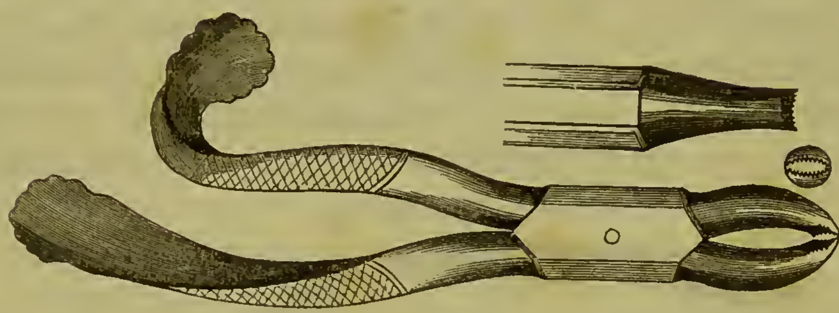
FIG. 140.



For the extraction of the upper incisors and cuspids, one pair only is necessary. (Fig. 141.) These should be straight, with grooved or crescent-shaped jaws, accurately fitted to the necks of the teeth. The beak should also be thin, so that they may be easily introduced under the gum, up to the edge of the alveolus. And, like the superior and inferior molar forceps, the

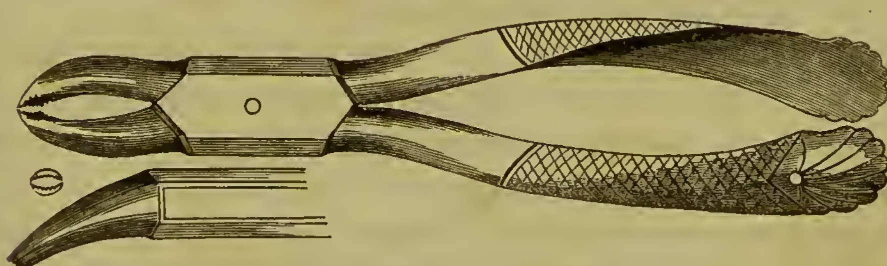
handles should be large enough to prevent them from springing in the hand of the operator, with a hook formed at the end of one of them.

FIG. 141.



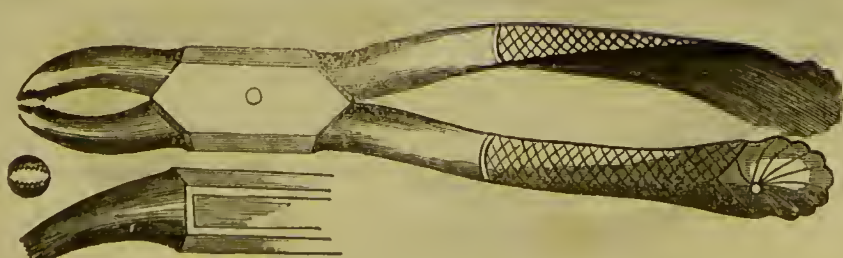
For the extraction of the lower incisors, a pair of very narrow-beaked forceps are necessary, to prevent interfering with the teeth adjoining the one to be removed. The beak below the joint of the instrument should be bent downward at an angle of about twenty-five degrees with the handles. (Fig. 142.) This is also a very valuable instrument for the extraction of the roots of teeth.

FIG. 142.



An instrument similarly shaped, but with the beak much longer, makes one of the most universally applicable instruments that can be devised. The beak should be made strong, but very narrow.

FIG. 143.

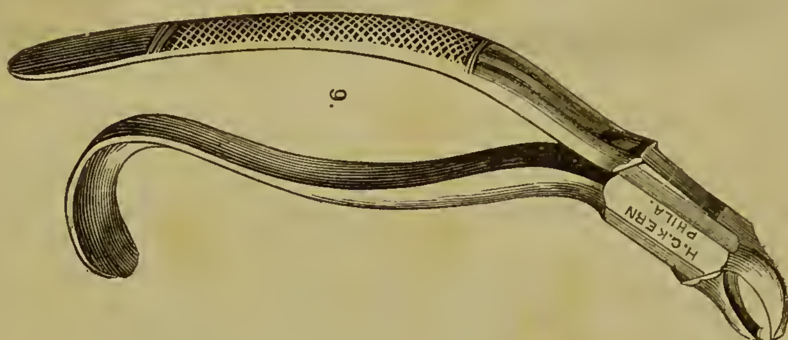


Forceps for the extraction of bicuspids should have their jaws so bent as to be easily adapted to these teeth; they should be

narrow and have a deeper groove on the inside than those for the upper incisors and cuspids; like them, they should be thin, yet strong enough to sustain the pressure which it may be necessary to apply. One pair will answer for the bicuspids of both jaws, but in this case both handles must be straight. (Fig. 143.)

For the removal of the cuspids of the lower jaw, the hawk's-bill forceps, (Fig. 144) with crescent-shaped beaks, are often employed; but the instrument last described is, we think, better

FIG. 144.

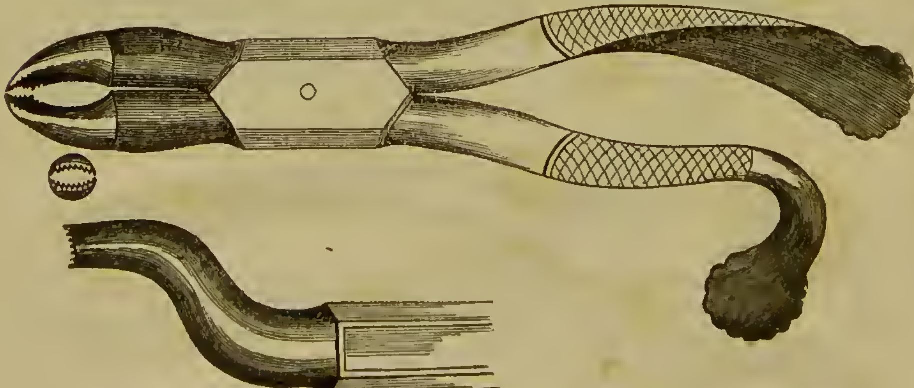


suited to the extraction of these teeth, and can be more conveniently applied. No separate instrument, therefore, is required for the removal of the inferior cuspids.

The dentes sapientiæ can, in a large majority of cases, be as readily extracted with the bicuspid forceps as with any other; and these can be as conveniently applied to the teeth of the upper as to those of the lower jaw.

But there is another kind of forceps, which may be employed for the removal of the upper wisdom teeth, where the bicuspid

FIG. 145.



forceps cannot be used. The beak of these is bent above the joint, forming nearly two right-angles, as shown in Fig. 145.

These forceps were, we believe, invented by Dr. Edward P. Church,* about the year 1830, and in those cases where the superior dentes sapientiæ are considerably shorter than the second molars, they can be successfully and advantageously employed; and indeed, in many cases, they cannot be reached with any of the above-described extracting instruments. These forceps are also useful in the extraction of roots of teeth situated behind a bicuspid or molar tooth which has a very long crown. The handles of these, as of all other forceps, should be no longer than is absolutely necessary for the accommodation of the hand of the operator.

A great variety of forceps have been invented and used for the extraction of teeth; but the author has not seen any that he deems comparable with those which he has just described. Seven pairs are all that are really necessary; and these, if properly constructed, are better and more efficient than thirty pairs of the awkwardly-contrived instruments which many dentists use.

In truth, there is scarcely any instrument used in dentistry that has called forth more ingenuity in devising various shapes. Almost every practitioner has some peculiar pattern of his own which will accomplish what no other can. Doubtless many of these instruments are very excellent; but it often happens that an inventor learns, by dint of practice, to do with some pet forceps of his own contrivance what might as easily have been done with a simpler one already in use. We would not, however, be understood as saying that patterns in present use admit of no improvement. What we do assert is, that skill in the use of a few instruments is preferable to crowding one's case with an unnecessary number.

* Dr. Church was an ingenious and talented man, and during the four years of his brief professional career he acquired a reputation for skill, which few, in so short a time, have been able to achieve; had his life been spared, he would soon have ranked among the very first practitioners in the country. Born in the western part of the State of New York, he chose the Mississippi Valley as the field of his professional labors, intending ultimately to locate in Cincinnati; but while on a visit to his family, in 1832, he fell a victim to the Asiatic cholera, in the twenty-sixth year of his age.

MANNER OF USING THE FORCEPS.

In describing the manner of using these instruments, we shall commence with the extraction of the incisors of the upper jaw. These are generally more easily removed than any of the other teeth.

The use of the gum lancet should generally precede the application of either the forceps or the key. Many dentists object to the operation as unnecessarily inflicting double pain. Some have their forceps made with thin sharp blades so as to sever the gum on two sides in the act of pressing up the instrument. This practice may be admissible, perhaps necessary in certain exceptional cases; as with children, or nervous persons, whom the act of lancing might deter from permitting the operation to be completed. But we are fully satisfied that as a rule it is very objectionable, either in the use of the key or of forceps. After separating the gum from the neck of the tooth, it should be grasped with a pair of straight forceps (Fig. 141), and pressed several times, in quick succession, outward and inward, giving it at the same time a slight rotary motion, which should be continued until it begins to give way; then, by a slight downward pull, it is easily removed. If the tooth is much decayed, it should be grasped as high up under the gum as possible, and no more pressure applied to the handles of the instrument than may be necessary to prevent it from slipping. Teeth are often unnecessarily broken by not attending to this precaution.

The same directions will, in most cases, be found applicable for the removal of a lower incisor. But the arrangement of these teeth is sometimes such as to render their extraction rather more difficult. The forceps best calculated for their removal are represented in Fig. 142.

For the extraction of a cuspid, more force is usually required, than for the removal of an incisor, because of the greater size and length of its fang. The straight forceps (see Fig. 141) should be employed for the removal of the superior, and the curved-beaked forceps (Fig. 143) for the inferior cuspids. In the extraction of these teeth, less rotary motion should be given to the hand than in the removal of the incisors: in every other

respect, the operation is performed in the same manner. The inferior cuspids usually have longer roots, and are more difficult to remove than the superior.

Very little rotary motion can be given to a bicuspid, especially an upper one, in its extraction. After it has been pressed outward and inward several times, or until it begins to give way, it should be removed by pulling in the direct line of its axis. For the extraction of the upper, the forceps represented in Fig. 141, and for the lower, those represented in Fig. 143, are the proper instruments to be employed; unless the crown has become so much weakened by decay, that it will not bear the requisite amount of pressure. In this case, the gum on each side should be separated from the alveolus, about an eighth or three-sixteenths of an inch, and slitted so as to permit the application of the narrow-beaked forceps, Fig. 142. With these, the alveolar wall on each side may be easily cut through, and a sufficiently firm hold obtained upon the root of the tooth, for its removal. These forceps will also be found better adapted for the removal of the molars, when in a similar condition, than any other instrument.

The upper molars, having three roots, generally require a greater amount of force for their removal than any of the other teeth. They should be grasped as high up as possible, with one of the forceps represented in Fig. 139, and then pressed outward and inward, until the tooth is well loosened, when it may be pulled from the socket. If the forceps used for the extraction of the upper molars are of the right description and properly applied, they will be found the safest and most efficient instruments that can be employed for their removal.

The superior dentes sapientiæ are usually less firmly articulated to the jaw than are the first and second molars; they are therefore more easily removed. When their crowns are sufficiently long to admit of being grasped with the bicuspid forceps (Fig. 143), they should be removed with this instrument; but when this cannot be applied without interfering with the anterior teeth, the forceps represented in Fig. 145 may be substituted.

The inferior molars, although they have but two roots, are often very firmly articulated, and require considerable force for their removal; and it sometimes happens that, when the approxi-

mal side of one has been destroyed by caries, the adjoining tooth has impinged upon it in such a manner as to constitute a formidable obstacle to its extraction. Two teeth are often removed in attempting to extract one thus situated, unless the precaution is taken of filing off the side of the encroaching tooth. This should never be omitted in the extraction of a lower molar or bicuspid, locked in the manner just described. It sometimes, though less frequently, happens that the upper teeth impinge upon each other in the same manner; in this case, also, the adjoining tooth should be filed sufficiently to liberate the one that is to be extracted before attempting its removal. In applying forceps to an inferior molar, the points on the beak of the instrument should be forced down between the roots; after having obtained a firm hold, the tooth should be forced outward and inward several times in quick succession, until its connection with the jaw is partially broken up, and then raised from the socket. If the tooth has decayed down to the neck, the points of the beak may include the upper edge of the alveolus, through which they will readily pass, on applying pressure to the handles, and in this manner a secure hold will be obtained upon the tooth. The same should also be done in the extraction of a superior molar in this condition.

The dentes sapientiæ in the lower jaw, when situated far back under the coronoid processes, are oftentimes exceedingly difficult to extract; but with forceps like those represented in Fig. 142, they may always be grasped by an expert operator; except in those cases where their crowns have been destroyed by caries, when a portion of the alveolus should be cut away, either with forceps, or a strong sharp-pointed instrument, previously to attempting their removal. It occasionally happens that the roots of these teeth are bent in such a manner as to constitute a considerable obstacle to their removal. But when this is the case, the roots are almost always turned posteriorly toward the coronoid processes; so that after starting the tooth, if the operator is unable to lift it perpendicularly from the socket, he will have reason to suspect its retention to be owing to an obstacle of this nature. To overcome this, as he raises his hand, he should push the crown of the tooth backward, making it describe the segment of a circle; for should he persist in his efforts to

remove it directly upward, the root will be broken and left in the jaw.

It sometimes happens that the roots of the first and second molars of both jaws, and those of the superior dentes sapientiæ, are bent, or else diverge or converge so much as to render their extraction exceedingly difficult. The convergency of these roots is often so great that, in their removal, the intervening wall of the alveolus is brought away; but neither from this, nor from the removal of a portion of the exterior wall, will any unpleasant results follow. Similar malformations are occasionally met with in the roots of the bicuspids, the cuspids, and even the incisors.

Other obstacles sometimes present themselves in the extraction of teeth, which the judgment and tact of the operator alone will enable him to overcome. The nature and peculiarity of each case will suggest the method of procedure most proper to be pursued. The dentist should never hesitate to embrace a portion of the alveolus between the jaws of the forceps, when necessary to enable him to obtain a firm hold upon the tooth. The removal of the upper edge of the socket is never productive of injury, as it is always subsequently removed, more or less rapidly, by the process of absorption. When the crown of a tooth has become so much weakened by disease that it will not bear the pressure of the instrument, it may be removed in this manner without inflicting upon the patient half the pain that would be caused by the attempt to spare the thin, perishable alveolar walls.

MANNER OF EXTRACTING ROOTS OF TEETH.

The extraction of roots of teeth is sometimes attended with considerable difficulty; but, generally, they are more easily removed than the whole teeth, especially the roots of the molars; for after the destruction of their crowns, an effort is usually made by the economy to expel them from the jaws. This is done by the gradual absorption of the alveolus, together with the filling up of the socket by a deposition of ossific matter at the bottom; whereby the articulation of the root becomes weakened, and its removal rendered proportionably easier. The

alveolar cavities are often wholly obliterated in the course of two or three years after the destruction of the crowns of the teeth, and the roots retained in the mouth, simply by their connection with the gums; so that for their removal little more is necessary than to sever this bond of union with a lancet or sharp-pointed knife.

The instruments usually employed in the extraction of roots of teeth, are the hook, punch, elevator and screw; all of which are represented in Figs. 146 and 147. Although every dentist has them made to suit his own peculiar notions, the manner of using them, and the principle upon which they act, are the same. It will, therefore, be sufficient to say, that they should be of a convenient size, made of good steel, and so tempered as neither to bend nor break.

Fig. 146.

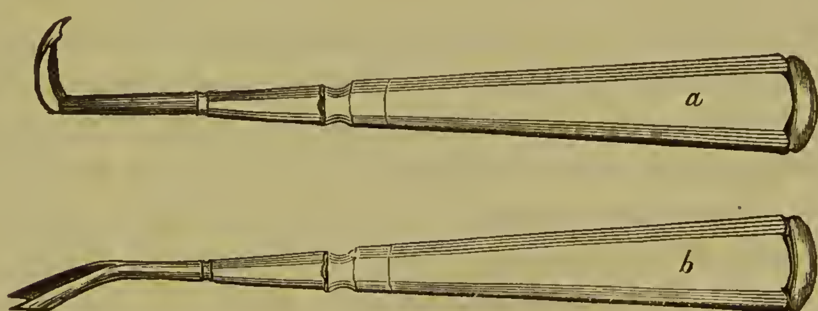
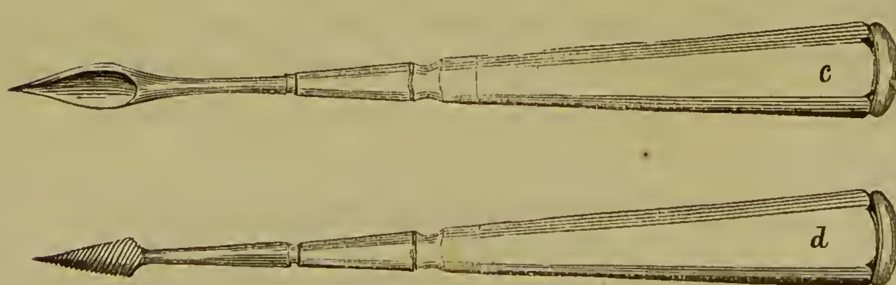


Fig. 147.



The hook *a*, Fig. 146, is chiefly used for the extraction of the roots of molar and bicuspid teeth on the left side of the mouth; the punch *b*, Fig. 146, for the removal of those on the right side; the elevator *c*, Fig. 147, for the extraction of roots on either side, as occasion may require; and the screw *d*, Fig. 147, for the removal of those of the upper front teeth.

Considerable tact is necessary for the skillful use of these instruments, and this can only be obtained by practice. Great

care is requisite in using the punch and elevator, to prevent them from slipping and injuring the mouth of the patient. Whenever, therefore, either of these are used, the forefinger of the left hand of the operator should be wrapped with a cotton or linen rag and placed on the side of the root opposite to that against which the instrument is applied, so as to catch the point in case it should slip.

But, for the removal of the roots of bicuspids and molars, and often for those of the cuspids and incisors, the narrow beaked forceps, recommended for the extraction of the lower incisors (see Fig. 142), may be used more effectively than any other instrument. When the root is decayed down to the alveolus, the gum should be separated from it, and so much of it as may be necessary to obtain a secure hold upon the root, included between the jaws of the beak of the forceps; for these being very narrow, readily pass through the alveolus, and a firm hold is at once obtained upon the root; then, after moving it a few times, outward and inward, it may easily be removed from its socket. There are some cases, however, in which the punch, hook, and elevator may be advantageously used. We have also occasionally met with cases where we have succeeded in removing roots of teeth with great ease, by means of an elevator shaped like the blade of a knife, first forcing it into the socket by the side of the root, and then turning it so as to make the back press against the former, and the edge against the latter. When this instrument, represented in Fig. 148, is used, the blade should not be more than an inch in length, and it should be straight, short at the point, and have a very thick back, that it may not

FIG. 148.

break in the operation. In using the common elevator, it is necessary that there should be an adjoining tooth or root to act as a fulcrum. When this can be employed, a root, or even a whole tooth, may sometimes be removed with it; but as a general rule, forceps should be preferred to any of these instruments.

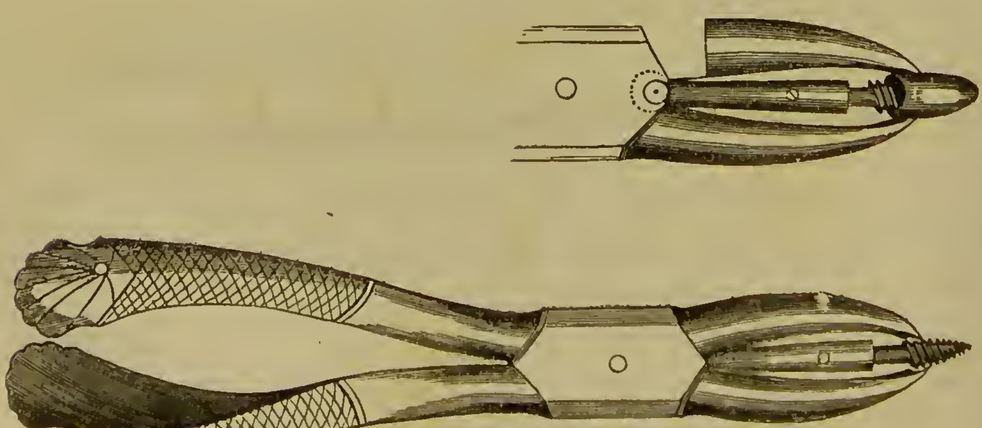
For the extraction of the roots of the upper front teeth, after they have become so much funneled out by decay as to render

their walls incapable of sustaining the pressure of forceps, the conical screw is invaluable. With this a sufficiently firm hold for the removal of the root can be obtained by screwing it into the cavity. But before it is introduced the soft decomposed dentine should be removed from the interior of the root with a triangular pointed instrument like the one represented in Fig. 149.

Fig. 149.

Dr. S. P. Hullihen has invented a most valuable and useful instrument for the removal of the roots of the superior incisors and cuspids when in the condition just described. It combines the advantages both of the screw and forceps, as may be seen by the accompanying cut. It is thus described by the author: "Lengthwise, within, and between the blades of the beak, is a steel tube, one end of which is open, the other solid and flat, and jointed in a mortice in the male part of the joint of the forceps. When the forceps are opened, this joint permits the tube to fall backward and forward from one blade of the beak to the other, without any lateral motion. Within this tube is a spiral spring, which forces a shaft up two-thirds of the tube, the other part is a well tapered or conical screw. * * * * The shaft and tube are so fitted together, and to the beak of the forceps, that one-half of the rounded part of the shaft projects beyond the end of the tube, so that the shaft may play up and down upon the spring about half an inch, and the screw or shaft be embraced between the blades of the beak of the instrument."

Fig. 150.



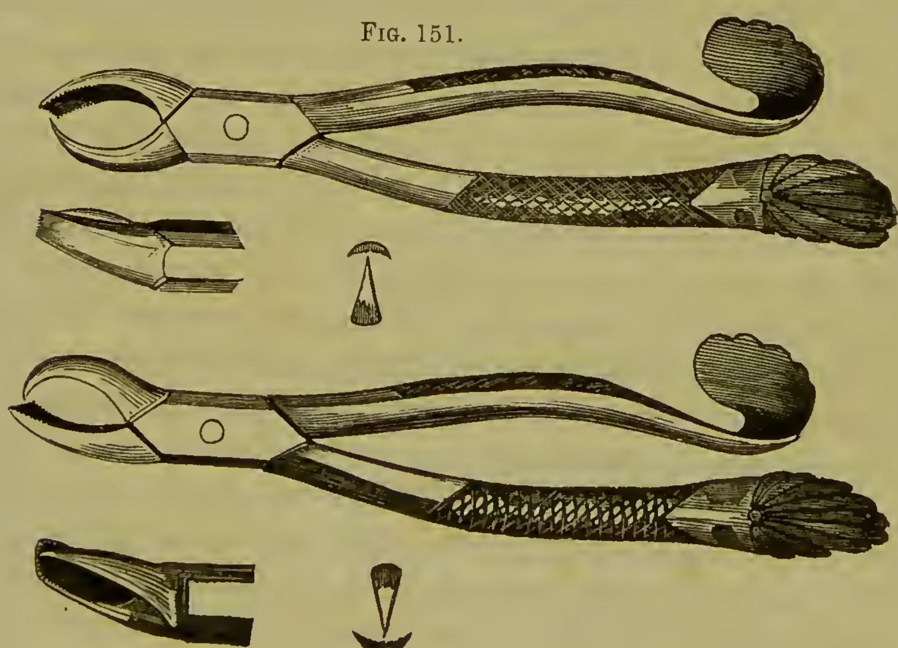
The instrument here represented (see Fig. 150), differs a little

from Dr. Hullihen's in the manner of its construction, though it acts upon precisely the same principle.

"The forceps," says Dr. H., "are used by first embracing the shaft between the blades.* Then screwing it as gently and deeply into the root as possible, the blades are opened, and pushed up on the root, which is then seized and extracted. The screw thus combined with the forceps, prevents the root from being crushed. It acts as a powerful lever when a lateral motion is given; it is likewise of advantage when a rotary motion is made; it prevents the forceps from slipping or from losing their action, should one side of the root give way in the act of extracting it; and is used with equal advantage where one side of the root is entirely gone."

The opportunities which the author has had of testing the value of this instrument, have been sufficient to justify him in stating that its merits are not overrated by the inventor. Every practitioner would, therefore, do well to provide himself with one of them.

FIG. 151.



For the extraction of the roots of the upper molars, before they have become separated from each other by decay, the forceps (Fig. 151), invented by Dr. Maynard, will be found highly valuable. The outer beak of each instrument is brought to a

* The author has a pair constructed so that the blades of the beak of the forceps grasp the upper extremity of the screw instead of the shaft.

sharp point, for perforating the alveolus between the buccal roots, and for securing between them a firm hold, while the inner beak is intended to rest upon the edge of the alveolus and embraee the palatine fang. By this means a sufficiently firm hold is secured to enable the operator to remove the roots of an upper molar without diffieulty. Two pairs, as represented in the engraving, one for the right and one for the left side are required. The advantage to be derived from foreeps of this deseription must be apparent to every dentist.

EXTRACTION OF THE TEMPORARY TEETH.

The temporary teeth should be extracted in the same manner as the permanent, and with the same instruments. If the power be properly direeted, very little foree is required for their removal; beeause the roots of these teeth have generally suffered more or less loss of substance before the operation is called for; and when they remain, the alveolar processes, at this early age, are so soft and yielding as to offer little resistanee to the tooth.

The operator should be careful not to injure the pulps of the permanent teeth, or the jaw-bone. Serious aceidents sometimes oeeur from an improper or awkward removal of these teeth. But, as has been before remarked, their extraetion is seldom required. It should only be resorted to for the relief of toothaehe, the cure of alveolar abseess, to prevent irregularity in the permanent teeth, or in ease of neerosis of the socket. And even in such cases, it is necessary to exereise mueh judgment in deeiding how far pain and inconvenience should be endured, rather than extraet the offending tooth; or how far the ehance of injury to the permanent teeth demands the removal of diseased milk teeth. Their premature extraetion is so often followed by a erowded state of the permanent teeth, that their indiserimінate removal, for trifling eauses, cannot be too strongly condemned.

HEMORRHAGE AFTER EXTRACTION.

It rarely happens that excessive hemorrhage follows the extraetion of a tooth. Indeed, it is oftener more desirable to pro-

mote bleeding by rinsing the mouth with warm water than to attempt its suppression. Nevertheless, cases do sometimes occur in which it becomes excessive and alarming. It has been known, in some instances, to terminate fatally; this, however, does not appear to be dependent upon the manner in which the operation is performed; but rather upon a hemorrhagic diathesis of body, attributable to a deficiency in the coagulating property of the blood. Hence, whenever a tendency to it exhibits itself in one member of a family, it is usually found to exist in all. Of the many cases which have fallen under our own observation, we shall mention only the following:

In the fall of 1834, Miss I., fifteen years of age, had the second molar on the left side of the upper jaw removed. The hemorrhage, immediately after the operation, was not greater than usually occurs, and in the course of half or three-quarters of an hour, it ceased altogether. But at about twelve o'clock on the following night, it commenced again, the blood flowing so profusely as to excite considerable alarm. A messenger was immediately sent to ask our advice, and we directed that the alveolar cavities should be filled with pledgets of lint, saturated with tincture of nut-galls. Two days after, at about six o'clock in the morning, we were hastily sent for by the young lady's mother, and when we arrived at her residence, were informed that the bleeding had then been going on for about four hours. During this time more than two quarts of blood had been discharged. The blood was still oozing very fast. After we had removed the coagulum, we filled the socket with pieces of sponge, saturated, as the lint had been, with tincture of nut-galls. When firmly pressed in, and secured by a compress, the hemorrhage ceased. These were permitted to remain until they were expelled by the suppurative and granulating processes. We afterwards had occasion to extract one tooth for a sister and two for the mother of the young lady; and a hemorrhage, similar to that just described, occurred in each case.

We have had, perhaps, some thirty or forty cases of this description, but never found it necessary, except in one instance, to adopt any other course of treatment than that described in the case just narrated. More powerful remedies, however, are sometimes employed. Some use a solution of the sulphate of copper,

or of the nitrate of silver, while others employ the actual cautery. Tannic acid is an excellent styptic, and will answer well, in combination with the compress of lint or cotton, for most cases. For more obstinate cases the per-sulphate of iron will be found to be the most potent styptic of the materia medica. But if pressure be so applied as to act directly upon the mouths of the bleeding vessels, it will almost always arrest the hemorrhage. The author has, in two cases, found it necessary to have recourse to the actual cautery.

The following case is quoted by Dr. Fitch from *Le Dentiste Observateur, par H. G. Courtois*, Paris, 1775:

"A person living in Paris called on me to extract a canine tooth for him. On examining his mouth, I thought that the man was attacked with scurvy; but this did not seem sufficient to hinder the patient from having his tooth extracted; nor would he consent to its remaining on account of the pain which it gave him. After the tooth was extracted, it did not appear to me that it bled more profusely than is customary after similar operations. The following night I was called upon to see the patient, who had continued to bleed ever since he left me. I employed, for stopping this hemorrhage, agaric from the oak bark, which I commonly used with success. The following day I was again sent for; the bleeding still continued. After having disburdened the mouth of all the lint-pledgets, which I used for making compression at the place where the blood appeared to come from, I made the patient take some mouthfuls of water to clear his mouth of all the clots of blood with which it was filled; I perceived, then, that the blood came no longer from the place where I had extracted the tooth, but from the gums; there was not a single place in the whole mouth from which the blood did not issue. I called in the physician, who ordered several bleedings in succession, besides astringents, taken internally; and gargles of the same nature; but all these attempts to improve the coagulability of the blood were made to no purpose. It was not possible to stop the hemorrhage. The patient died the ninth or tenth day after the extraction of the tooth."

Mr. Snell mentions a similar case, which also terminated fatally.

CHAPTER ELEVENTH.

THE USE OF ANÆSTHETIC AGENTS IN THE EXTRACTION OF TEETH.

Of the various agents that have been employed for the prevention of pain during surgical operations, sulphuric æther and chloroform have proved more successful and been more generally used than any others. The practicability of producing anæsthesia with the former was first brought prominently before the medical and dental profession in 1846, by Dr. W. G. S. Morton, dentist, of Boston, Mass.; and with the latter, in 1847, by Professor J. Y. Simpson, of Edinburgh, Scotland. The anæsthetic effect is obtained by inhalation of the vapor, and is supposed to be nothing more than a transient state of intoxication, which usually disappears almost immediately after the discontinuance of the administration, though in many cases it has proved fatal. For this reason, we do not think that agents capable of producing such powerful and dangerous effects as æther and chloroform, should be used in so simple an operation as the extraction of a tooth. The first, however, is less dangerous than the second; but its anæsthetic effect is less certain and prompt, from seven to ten minutes being usually required, whereas with the other, it is obtained in from thirty seconds to two minutes. When æther is used, from six to ten or fifteen ounces are employed; but with chloroform, it is rarely necessary to administer more than from thirty to one hundred and fifty drops. What we have said about sulphuric æther applies equally to chloric æther, a substance very extensively used, if not first proposed, by the late Professor Warren, of Boston.

A number of instruments have been gotten up for the inhalation of the vapor of these agents, but the simplest and, we think, the best method of administration is from a hollow sponge, a napkin, or a pocket-handkerchief.

It may not always be possible, for any one, in the adminis-

tration of either of the foregoing agents even to a person supposed to be free from any special proclivity to disease from organic derangement, to pronounce, *a priori*, that no bad effect will result from it; but all agree that it is unsafe to give it to a patient laboring under disease of the heart, brain, or lungs. The practitioner, therefore, whether medical or dental, should be well assured, before giving æther or chloroform, and especially the latter, that these organs are not only free from disease, but also from any morbid tendency, as ignorance with regard to this matter might lead to fatal consequences. It should be given cautiously under any circumstances, and the pulse should never be permitted to fall, during the inhalation, below sixty, or at most, fifty-five beats a minute; but if from carelessness or any other cause, the patient should sink and the pulsation cease, the agent should be immediately removed from the mouth, and if occupying a sitting posture, he should be placed in a reclining position, air freely admitted, cold water dashed in the face, the feet and hands rubbed with hot salt or mustard, and if necessary, artificial respiration made and galvanism applied. In addition to these means the tongue should be depressed and drawn forward by a finger thrust deeply into the mouth, as recommended by Ricord; or Dr. Marshall Hall's "ready method" may be faithfully and patiently practised.

It is thought by those who have had most experience in the use of æther and chloroform as anæsthetic agents, that their administration is attended with less danger when the patient is in a reclining than when in a sitting posture. It would be well, therefore, when either is used preparatory to the extraction of teeth, to place the patient as nearly as possible in such a position; when the dentist is provided with an operating chair having a movable back this can be very readily done.

Suspension of nervous sensibility, induced by inhaling the vapor of the above mentioned agents—or amylen, a more recently discoved anæsthetic—is general, every part of the body being affected alike; but partial or local anæsthesia may be procured by other and less dangerous means. Congelation or freezing, first proposed and employed in the Charité Hospital, Paris, by an *interne* of M. Velpeau, and subsequently recommended by Dr. James Arnott, of London, has been resorted to for several

years, both by surgeons and dentists, and practiced to a limited extent, with some success. This may be effected by applying a mixture of pounded ice and common salt in the proportion of two or three parts of the former to one of the latter, to the part on which the operation is to be performed. But in the use of this, care is necessary to prevent reducing the temperature too much, as in this case, loss of vitality would be occasioned by it. We have heard of a few cases in which this has occurred, but we believe it was owing in every instance to carelessness or want of judgment on the part of the operator, as to the length of time the application of the mixture should be continued.

Several instruments have been invented for the application of the freezing mixture to teeth preparatory to extraction. The one which we consider best adapted for the purpose, was designed by Dr. Branch, of Chicago, Ill. It consists of a hollow tube about an inch or a little more in diameter, with about five-eighths of an inch cut out at one end on either side that it may readily be placed over a tooth. To this is attached a sac of finely prepared membrane large enough to hold a tablespoonful of the mixture. The hollow of the tube is occupied by a steel wire spiral spring. Just before using it a sufficient quantity of the freezing mixture is put in the tube; the end of the latter is placed over the tooth, when the ice and salt are forced up gently around it by pressing on the spring at the other extremity of the instrument. Two tubes are employed; one straight for teeth in the anterior part of the mouth, the other bent near one end, for the more convenient application of the mixture to a molar tooth.

The sudden application of such intense cold to a sensitive tooth, or to one which has not lost its vitality, is often productive, at first, of severe pain; on this account, many object to the use of it, preferring the momentary suffering consequent upon the operation of extraction than that occasioned by the freezing mixture. But this effect is rarely experienced in its use on dead teeth or the roots of teeth which have lost their vitality; hence, the application of it has to such proved more satisfactory than to living teeth.

With the view of obviating the above objection to the use of cold as an anæsthetic agent, Messrs. Horne and Thornthwaite,

opticians, at the suggestion of Mr. Blundell, dentist, of London, contrived and constructed an apparatus, by which the temperature may be gradually diminished; say from 98° or blood heat, down to zero, or any required degree, thus preventing the pain consequent upon the sudden application of the freezing agent. The apparatus is thus described. "The required amount of water is cooled down by means of ice and salt to about zero, in a vessel called the refrigerator. To this vessel is attached another, called a graduator, containing warm water at about 100°, and so constructed as to allow the slow admixture of its contents with the chilled water in the refrigerator, and thus produce a gradually diminishing temperature, for the purpose of preventing sudden shock and pain to the teeth, which a direct application of cold would inevitably cause. A tube conveys this graduating current into a terminal portion constructed of very fine membrane, which adapts itself to the form of the gums, and wholly surrounds the tooth to be withdrawn. The fluid then passes away through an exit tube. In this manner a constant current of cold, at a decreasing temperature, is made to pass over the part, abstracting therefrom all heat, and with it the power of feeling." The gum and alveolar membrane being now in a frozen condition, and, consequently, devoid of sensibility, the extracting instrument is applied and the tooth removed.

It would seem, from all that has been said of this contrivance, that it is admirably adapted to the purpose for which it was designed.

In the early part of the year 1858, Mr. J. B. Francis, dentist, of Philadelphia, announced the discovery of an original method of producing local anæsthesia, said to be peculiarly applicable to the extraction of teeth which consists in passing an electro-galvanic current through the tooth at the moment of its removal. The discovery was submitted to the Franklin Institute, Philadelphia, and the committee to whom it was referred for examination, composed in part of dentists, reported favorably in regard to the claims of the inventor.* One of the members of this com-

* The following is an extract from the report referred to above. "The Committee is satisfied, from the observation and experiment of its members, that in a large majority of cases of extraction with this apparatus, *no pain whatever* is felt by the patient.

"To test the question whether the effect might not be simply mental, the circuit was

mittee, W. S. Wilkinson, states that he had extracted between four and five hundred teeth, applying the electric current; and that in ninety-five per cent. of the cases it was done without pain to his patient.

The method of applying it is very simple. One pole (the negative is preferable) of the electro-galvanic machine is attached to one of the handles of the forceps by means of a flexible conductor, while the metallic handle of the other is grasped by the patient; the power of the current being, previously to the operation, graduated by the piston of the coil, while the patient holds the forceps in the other hand. The current should only be sufficiently powerful to be distinctly felt. The circuit through the tooth is not made until at the instant the operation begins. The closing and breaking of the galvanic circuit is managed either by the foot of the operator or by an assistant.

A small electro-galvanic battery, arranged for this purpose, having been placed in the office of the author, soon after the announcement of the discovery, he has had frequent opportunities of applying this new agent in the extraction of teeth. Thus far, about nine out of ten of those who were placed under its influence, while undergoing the operation, assured him that they either experienced no pain at all, or only very little—not a tenth part of what they had experienced under the operation on former occasions. In almost every case in which the tooth was grasped, allowing the instrument to come in contact with only the edge of the gum, the operation appeared to be painless, or nearly so. But when pushed up a considerable distance between it and the tooth, the suffering was not appreciably diminished, the electric current in such cases seeming to be too much diffused. It is stated by those who have made the experiment, that this diffusion of the electric current may be prevented

broken without the patient being aware of it, when the usual pain was experienced, although, in the same patient, and on the same occasion, tooth had been removed while the current was flowing without causing pain.

"In the less successful cases, the teeth were broken and diseased below the level of the gum, and the pain, in adjusting the forceps previous to the completion of the circuit and the extraction, was considerable.

"The sensation produced by the passage of the current is not painful, it being so adjusted as to be *just perceptible* to the patient. The committee believes its use to be entirely without danger, and not likely to be followed by any unpleasant after effects."

by insulating the outer portion of the instrument with a coating of gutta-percha or by japanning. The author has not tried this expedient.

How it is that the passage of an electric current through a tooth should prevent pain, may be explained by supposing the subtle fluid to exhaust the sensibility of the nerves of the parts comprised in the operation; and that it does in a majority of cases, is attested by many who have been placed under its influence. It may be nothing more than a mere substitution of one sensation for another: but whether its application will become general, or its efficacy as an anæsthetic agent be fully established, remains for future experience to settle.

The experience of the profession, up to 1863, may be briefly summed up thus: In one-fourth of the cases it relieves or neutralizes the peculiar pain of extraction, in one-half it has but little effect, and in the remaining fourth it very decidedly aggravates the pain. It has, however, the advantage over chloroform and the freezing process, of being without any serious sequelæ.

As the use of anæsthetic agents of any kind in the extraction of teeth is attended with inconvenience, nearly always delaying the operation, the author is of opinion that their employment, as a general thing, should be dispensed with. He never encourages their use, and rarely finds it necessary to employ them. In the case of females with a highly nervous organization, it may now and then be advisable to give a temporary courage to endure pain by the administration of a teaspoonful of brandy. But we have found less trouble with delicate females than with stalwart men; and to the latter we certainly would never advise this use of stimulants. Indeed the extraction of a tooth is so simple an operation, seldom requiring more than from two to five seconds for its performance, that most persons should rather submit to it at once, than have it protracted by the application of an agent for the prevention of the momentary pain which it occasions.

CHAPTER TWELFTH.

ATROPHY OF THE TEETH.

That peculiar structural alteration of the teeth, designated *atrophy*, is less frequent in its occurrence than any other disease to which these organs are liable; but as the progress of the affection usually terminates with the action of the causes concerned in its production, it has scarcely been deemed of sufficient importance to merit serious consideration. Hence its ætiology and pathology have not been very carefully investigated. Indeed most writers upon the diseases of the teeth have overlooked the affection altogether; while a few have merely alluded to it, without describing the characteristics of even its principal varieties. Whether we shall now be able to throw any additional light upon the subject, or establish the correctness of any opinions already advanced, we leave to others to determine.

The strict applicability of the term *atrophy* may, perhaps, be considered as somewhat questionable; as the two principal varieties of the affection consist in a congenital defect in some portion of the enamel of two or more teeth, rather than in the wasting, from want of nourishment, of any of the dental tissues. This term would seem to be rendered still more inappropriate by the fact, that neither of the varieties to which we have referred occurs subsequently to the formation of the enamel. But as the congenital form of the disease is evidently the result of altered function in a portion of one or more of the formative organs—if not of absolute degeneration, from vicious nutrition—we are disposed to regard the term as the most applicable of any that can be applied to it.

Mr. Fox speaks of a defect, sometimes met with in the organization of the enamel, which he terms honey-combed, characterized by a yellow color, and a great number of indentations upon its surface, giving to the teeth the appearance of "the exterior of a sponge." He refers these defects to a deviation from the

natural action of the membrane which secretes the enamel, dependent upon some "peculiarity of constitution," during the first months of infancy. He thinks it is liable to occur in several children of the same family, and that teeth thus affected are less liable to decay than those which have beautiful and transparent enamel.*

M. Delabarre, an ingenious physiologist, and for the most part a close and very accurate observer, has, probably, approached nearer to a correct explanation of the true cause of odontatrophia than any other writer. But he has given to one of the varieties—consisting of perforations of the enamel—the improper term *erosion*, which is an entirely distinct affection. His other variety — consisting of discoloration and deficiency of enamel—he has correctly named atrophy. The latter he thinks invariably congenital; while the former, erroneously termed erosion, he believes may be either congenital or accidental. Believing the doctrine of Hunter, Jourdain, Fox, and Cuvier, as to the formation of enamel, to be erroneous, Mons. Delabarre asserts that "this portion of a tooth is formed from an immense number of exhalants which cover the crown, forming a sort of imperceptible velvet;" which in fact correspond exactly with the corpuscles or fibres of the enamel membrane of Raschkow. These he regards as integral parts of the tooth, and believing the enamel fibres to be secreted by them, he ascribes the affection under consideration to their vicious development or imperfect nutrition.

Lefoulon adopts the views and almost the precise language of Delabarre, in the description which he gives of the affection. Maury treats of atrophy and erosion as one and the same disease. But in describing atrophy he notices the distinctive peculiarities by which each affection is characterized.† In describing the difference between erosion and atrophy, M. Delabarre says, the part atrophied is deformed and deprived of the enamel, and that the teeth are yellow and sensitive, the touch of the finger causing pain: but in erosion, if the crystals of the enamel are not wholly destroyed, the bottom of the pits are of a white color,

* Natural History and Diseases of the Human Teeth; American edition, pages 57, 58 and 59.

† Traité Complet de l'Art du Dentiste, pp. 99 and 100.

and on being touched no disagreeable sensation is experienced; if, on the contrary, the crystals are destroyed to the dentine, the part thus denuded is irritable.

In an article on erosion, Maury gives a very accurate description of several varieties of atrophy of the teeth. The first, he represents as consisting of deep irregular white, or light yellow spots, situated in the enamel of the tooth, without affecting the smoothness of its surface. The second, as characterized by small crowded holes, or irregular depressions, resembling quilting; or as consisting of transverse sinuosities, single or divided by prominent lines, which are sometimes "yellow, but of the color of the enamel." The third variety affects the dentine as well as the enamel, reducing the dimensions of the crown of the tooth sometimes to one-third its natural size, and not unfrequently dividing it by a deep circular groove or depression.

None of the phenomena here described are produced by the action of corrosive agents, or are the result of chemical decomposition either of the enamel or dentine, but are manifestly dependent upon other causes. The term erosion, therefore, cannot with propriety be applied to either variety of the affection just noticed. Although Maury has given, under the term erosion, a better description of the principal varieties of dental atrophy than any other writer, he has omitted some things which it will be proper to mention. In treating of these different varieties, therefore, we shall change, somewhat, the order in which he has arranged them.

Odontatrophia may very properly be divided into three varities. Each has characteristic peculiarities which distinguish it from either of the others. Two are always congenital, and the other, although most frequently congenital, sometimes occurs subsequently to the eruption of the tooth.

First variety. The peculiarities that distinguish this variety of atrophy from either of the others are, that it never impairs the uniformity and smoothness of the surface of the enamel, and is characterized by one or more white, or dark or light brown, irregularly shaped spots, upon the labial or buccal surface of the tooth. It occurs oftener than the third variety, and less frequently than the second. It rarely appears on more than one or two teeth in the same mouth, though several are sometimes

marked by it. It is seen on the molars more frequently than the bicuspids, and much oftener on the incisors of the upper jaw than any of the other teeth. We do not recollect to have ever observed it on the cuspids of either jaw, nor on the palatine or lingual surfaces of the incisors.

The enamel is much softer on the affected than on the unaffected parts of the tooth, and may be easily broken and reduced to powder with a steel instrument. It seems to be almost wholly deprived, in these places, of its animal constituents, and to have lost its connection with the subjacent dentine. The size of the atrophied spots are almost as variable as their shape, but the only harm resulting from them, is the unsightly aspect they sometimes give to the tooth.

As we have before remarked, this variety of atrophy is sometimes accidental, occurring subsequently to the eruption of the tooth, but in a large majority of the cases it is congenital. It is rarely seen on a temporary tooth. In all the cases which have come under our observation it was confined, to the best of our recollection, to the teeth of second dentition.

Second variety. This may be very properly denominated *perforating* or *pitting* atrophy; it gives to the enamel an indented or pitted appearance, the irregular depressions or holes extending transversely across and around the tooth. The pits are sometimes more or less distinctly separated one from another, by prominent lines; at other times they are confluent, and form an irregular horizontal groove. Sometimes they penetrate but a short distance into the enamel; at other times they extend entirely through it to the dentine. Their surface, though generally rough and irregular, usually presents a glossy and polished appearance—a peculiarity which always distinguishes this variety of the affection from erosion. The pits often have a dark brownish appearance, though sometimes they have the same color as the enamel on other parts of the tooth.

This variety of atrophy is never confined to a single tooth. Two, four, six or more corresponding teeth are always affected at the same time, in each jaw; and the corresponding teeth on either side precisely in the same manner, and in the same place. When more than two are marked, the distance of the pits from the coronal extremity of the tooth varies, according to the pro-

gress made in the formation of the enamel at the time of the operation of the causes concerned in the production of the affection. For example, when the line of pits in the central incisors is situated about two lines from their cutting edges, it will scarcely be one line from the cutting edges of the laterals, and only the points of the cuspids will be marked. When the indentations are nearer the edges of the central incisors, they will be on the edges of the laterals, and the cuspids will have entirely escaped.

Sometimes the teeth are marked with two or three rows of pits, and when this is the case, the patient has either had two or three relapses; or has been attacked two or three times in succession with some disease capable of interrupting the progress of the formation of the enamel.

Although the incisors are more frequently marked with these indentations than any of the other teeth, the cuspids, bicuspids, and even the molars are sometimes affected with them. When the disease attacks the molars, its effects are generally located on the grinding surface. The permanent teeth are more liable to be attacked than the temporary. We have known but one instance in which the latter were affected with the disease.

This variety of atrophy occurs oftener than either of the others, and though it sometimes gives to the teeth a disagreeable and unsightly appearance, it rarely increases their liability to decay.

Third variety. In this variety of atrophy the whole or only a part of the crown of a tooth may be affected; the dentine being often implicated as well as the enamel. The tooth usually has a pale yellowish color, a shriveled appearance, and is partially or wholly divested of enamel. Sometimes the crown is not more than one-half or one-third its natural size. Its sensibility is usually much increased, and its susceptibility to pain from external impressions is wonderfully excited by acids. It is also more liable than the other teeth to be attacked by caries. The root of the tooth is sometimes, though rarely, affected, and presents an irregular knotted appearance.

The disease is often confined to a single tooth, but it more frequently shows itself on two corresponding teeth in the same jaw. According to our observation, the bicuspids are more liable to be attacked than any of the other teeth. The temporary teeth

are rarely affected with it. This variety of atrophy occurs less frequently than either of the others; and although it increases the liability of the affected organs to caries, they sometimes escape until the twentieth or thirtieth year of age.

In the description which we have given of the three varieties of dental atrophy, we may have omitted to mention some of the peculiarities belonging to each, but we have pointed out their principal characteristics with sufficient accuracy to enable them to be distinguished one from another, and either from erosion.

CAUSES.

The first variety is evidently produced by some cause capable either of preventing or destroying the bond of union between the enamel and subjacent dentine, but what that cause is, becomes a question which it may be difficult to answer. Subsequently to the eruption of the teeth, it may be occasioned by mechanical violence, but we have never known more than one case in which it had resulted from this cause, and that was occasioned by a blow upon the tooth.

Now, whether the bond of union between this portion of the enamel and the subjacent dentine was immediately destroyed by the concussion of the blow, or whether it resulted from subsequent inflammation and the death of the intermediate membrane, is a question which may not be easily answered. If it were destroyed at once by the blow, one might be led to suppose that the change in the color of the enamel would have been observed immediately; but it may have resulted from some subsequent change or alteration in the animal constituents of this part of the enamel, following as a consequence of the injury produced by the violence of the blow. These are questions, however, which the present state of our knowledge does not enable us to solve. But that the white spot in this case resulted as a consequence of the blow, there cannot be the least shadow of doubt.

When the affection is congenital, as it almost always is, it is dependent upon some other cause; possibly upon disease in the pulp, or intermediate membrane, which constitutes the bond of union between the dentine and enamel, subsequently to the formation of the latter. But what the determining cause is of the

disease, whether produced in this way by simple local irritation, or by general constitutional disturbance, we are not prepared to say. One would be likely to suppose, if the atrophied spots were occasioned by disease of the pulp or intermediate membrane, the morbid action would scarcely confine itself to such narrow and circumscribed limits. But, whether the destruction of the intermediate membrane of the affected parts results as a consequence of actual disease, or merely from vicious nutrition; or whether from unknown causes it has failed to be developed here, it is certain that the fibres of this portion of the enamel are not united to the subjacent dentine; thus, not receiving a supply of nutrient fluid or vital principle, their animal frame-work partially or wholly perishes, leaving but little else than their inorganic constituents. The cause of this variety of congenital atrophy, it must be confessed, is very obscure; and in the absence of positive knowledge, we can only infer the cause from the nature of the affection. If it does not result from one or other of the above-mentioned causes, it is difficult to imagine in what way it is produced.

The cause of the second variety of odontatrophia is, we think, susceptible of a more satisfactory explanation. The formative organ of the enamel, as is now generally admitted, consists of a membrane, composed almost wholly of short hexagonal corpuscles or fibres, which correspond in shape and arrangement to the fibres of the enamel. This membrane is accurately moulded to the crown of the tooth, and, according to Raschkow, each fibre is a secretory duct, whose peculiar function it is to secrete the fibre of the enamel corresponding to it. It should also be borne in mind that the secretion of the earthy salts of the enamel commences at the coronal extremity of the tooth, gradually proceeding toward the base of the crown. Now we can readily conceive that some constitutional disease might interrupt the secretion of the earthy salts deposited in the enamel-cells or secretory ducts of the enamel membrane, for the formation of the enamel fibres; occurring at the time when this process is going on, it might prevent them from being filled, and cause them to wither or waste away, giving to this portion of the enamel the pitted appearance which characterizes this variety of atrophy. In other words, the secretion of the inorganic constituents of the enamel being in-

terrupted for a short time the horizontal row of cells in the enamel membrane, into which it should be deposited, will not be filled; consequently, as might readily be supposed, they will waste away, leaving a circular row of indentations around the crown of the tooth. But as soon as the constitutional disease has run its course, the secretion of the earthy salts will be resumed; and unless the child experiences a relapse, or has a second attack of disease, capable of interrupting this secretory process, the other parts of the enamel will be well formed.

Some writers ascribe the formation of these pits in the enamel to the chemical action of a corrosive fluid, or to an acidulated condition of the fluid contained in the dental sacs; but they have evidently confounded this affection with erosion. We believe, however, it almost always occurs as a consequence of some eruptive disease or catarrhal fever occurring during the "enameling" process; and there are many facts which go to sustain the correctness of this opinion. In nearly all the cases that have fallen under our observation, it was clearly traceable to measles, scarlatina, chicken-pox, catarrhal fever, or small-pox. It may, however, occasionally be produced by other constitutional diseases.

The third variety of dental atrophy, so far as our observation upon the subject has permitted us to form an opinion, always results from altered or vicious nutrition, caused by disease of the pulp or enamel membrane, or both, during the secretion of the dentine or enamel, accordingly as one or both are affected. We are inclined to believe that the disease in the dental pulp or enamel membrane may be produced either by local or constitutional causes, or both. But the information which we have been able to obtain in the cases that we have seen, concerning the state of the general health, and that of the mouth at the time of the dentinification of the pulp and the secretion of the enamel, has not been as satisfactory as we could have wished.

Since writing the foregoing, the following interesting case of dental atrophy has fallen under our observation:

Mrs. C. called, in 1850, to consult us concerning her daughter's teeth, which, from congenital defect, presented a most unsightly appearance. The girl was between nine and ten years of age. The cutting edges of the upper central incisors were badly pitted and very rough; the corresponding teeth in the

lower jaw had a transverse row of pits passing around them, about a sixteenth of an inch below their cutting extremities. Another row of pits, so close together as to form a rough groove, encircled the upper central incisors, about an eighth of an inch below the gum, and the laterals a little nearer their cutting edges; the lower incisors were similarly marked, but not quite so near the gum. The enamel, near the second transverse row of pits, and between it and the cutting edges of the teeth, was thin and of a light brown color. A little above the first row, on the central incisors, were two or three brown or opaque spots. The first permanent molars were also encircled with a row of indentations, about half way between their grinding surfaces and the gums.

On inquiry, we learned from the mother that the child had a light attack of measles when between eleven and twelve months old; of scarlet fever when about fifteen or sixteen months of age, and dysentery at about the twenty-first or twenty-second month.

Now, here we have the three varieties of atrophy on the same teeth; and the occurrence of constitutional diseases about the time when the affected parts of the teeth must have been receiving their earthy salts, would seem to establish, very conclusively, the connection of the one with the other.

TREATMENT.

The nature of this affection is such as not to admit of cure. The treatment, therefore, must be preventive rather than curative. All that can be done is to mitigate the severity of such diseases as are supposed to produce it, by the administration of proper remedies. By this means their injurious effect upon the teeth may, perhaps, be partially or wholly counteracted.

It seldom happens that atrophied teeth decay more readily than others, so that the only evil resulting from the affection, is a disfiguration of the organs. When the cutting edges of the incisors only are affected, the diseased part may sometimes be removed with a file without injury to the teeth.

CHAPTER THIRTEENTH.

NECROSIS OF THE TEETH.

By the term *necrosis*, when applied to a tooth, is meant the death of the entire organ; or of the crown and inner walls of the root; for it often happens that a degree of vitality is kept up in the outer portion of the dentine and the investing cementum by the peridental membrane, long after the destruction of the pulp and lining membrane. When other bones are affected with necrosis, the dead part is thrown off, and the loss supplied by the formation of new bone. But the teeth are not endowed with the recuperative power which the process of exfoliation calls for.

The density of a tooth is not sensibly, if at all, affected by the mere loss of vitality; but so great a change takes place in the appearance of the organ, that it may readily be detected by the most careless observer. After the destruction of the lining membrane, the tooth gradually loses its peculiar semi-translucent and animated appearance, assuming a dingy or muddy brown color; and this change is more striking in teeth of a soft than in those of a hard texture. The discoloration, too, is always more marked when the loss of vitality has resulted from a blow, than when produced in a more gradual manner. The discoloration is partly owing to the presence of disorganized matter in the pulp-cavity, and partly to the absorption of this matter by the surrounding walls of dentine.

After the destruction of the lining membrane, the tooth may receive a sufficient amount of vitality from the alveolo-dental periosteum to prevent it from exerting a manifest morbid influence upon the parts with which it is immediately connected. Teeth have occasionally been retained under such circumstances with apparent impunity for fifteen or twenty years. But when every part of a tooth has lost its vitality, it becomes an extraneous body. When this happens, inflammation of the socket ensues, the gum around it becomes turgid and spongy, and bleeds from the slightest injury, and the organ gradually loosens and ultimately drops out. In the mean time, the diseased action

frequently extends to the sockets and gums of the adjoining teeth.

The front teeth, being more exposed to injuries from violence, are more liable to necrosis than the molars.

CAUSES.

Necrosis of the teeth may be produced by a variety of causes, such as protracted fevers, the long continued use of mercurial medicines; by caries, and by external violence. The immediate cause, however, when not occasioned by a blow sufficient to destroy the vascular connection of the tooth with the rest of the system, is inflammation and suppuration of the lining membrane; but it may result from deficiency of vital energy and from impaired nutrition; for the author has met with several cases in which the loss of vitality could not be accounted for in any other way.

TREATMENT.

When a tooth, deprived of vitality, is productive of injury to the gums and to the adjacent teeth, it should be immediately removed; for, however important or valuable it may be, the health and durability of the others should not be jeopardized by its retention.

When necrosis of a tooth is apprehended, we should endeavor to prevent its occurrence, by the application of leeches to the gums, and by gargling the mouth with suitable astringent washes. If this plan of treatment is adopted at an early period, it will sometimes prevent the loss of vitality; but if long neglected, a favorable result need not be anticipated.

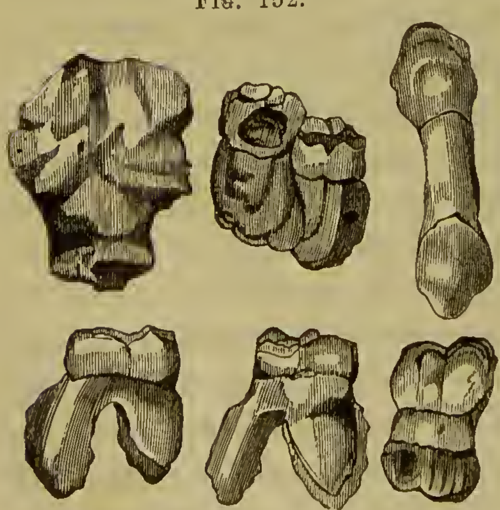
When the loss of vitality is confined to the crown and inner walls of the root, if the former is not seriously impaired by caries, it may be perforated, and the pulp-cavity and root cleansed and filled in the manner as directed in another part of this work. If the necrosed tooth is an incisor, the perforation should be made from the palatine surface, provided the approximal surfaces are sound. But previously to the introduction of a filling, the decomposed surface of the walls of the pulp-cavity should be completely removed, and if this does not restore the tooth to its natural color, the cavity should be filled with raw cotton, saturated with a solution of chlorinated soda, as directed in another chapter.

CHAPTER FOURTEENTH.

EXOSTOSIS OF THE ROOTS OF THE TEETH.

This disease is common to all bones, but it attacks no other part of a fully formed tooth than the root; for in the cementum alone, of the three osseous dental tissues, do we find that degree of vascularity which is a necessary condition of growth,—normal or abnormal. It usually commences at or near the extremity, then extends upward, covering a greater or less portion of the external surface. It sometimes, however, commences upon the side of the root and forms a large tubercle; at other times the deposit of the new bony matter is spread over its surface, often uniformly, but more frequently unequally. The osseous matter thus deposited, has usually the color, consistence and structure of the cementum, though sometimes it is a little harder and assumes a yellower tinge. The enlargement is in fact an hypertrophied condition of this substance. Those singular anomalies, occasionally met with, where enamel, dentine, and cementum are mixed up in shapeless confusion, are no exceptions to the rule that exostosis is confined to the cementum; for though classed under this head, these cases arise from disruption of the formative membranes, (possibly the result of violence,) each secreting its peculiar tissue. The hypertrophy is probably confined to the dentine; yet it is quite possible for the dentinal and enamel membranes in their then vascular condition to have an excess of development.

Fig. 152.



The deposit of osseous matter is sometimes so considerable, that the roots of two or more teeth are firmly united by it. Fig. 152, represents several examples of exodontosis of this description. One of these was presented to him by

Drs. Blandin and Reynolds, of Columbia, South Carolina. These with many other remarkable cases, including one presented by Dr. Hawes, in which three teeth are thus united, may be seen in the Museum of the Baltimore College of Dental Surgery.

An extraordinary case of dental exostosis was sent to the author for examination, by Dr. V. M. Swayze, of Easton, Pa. The tooth apparently is a dens sapientiæ, and the formation of the exostosis must have commenced with the dentinification of the pulp. It had spread over every part of the tooth, the crown as well as the root; it had ruptured and penetrated every part of the enamel membrane, but had not wholly destroyed the function of this organ, as nodules of enamel are seen in various parts of the exostosis. The tumor, including the tooth, is about as large as a common sized hickory nut.

Exodontosis often continues for a long time without producing any inconvenience whatever. It usually first manifests itself by slight soreness in the affected tooth, which increases as the fang becomes enlarged, until pain, either constant or periodical, and of a character more or less severe, is experienced.

The most remarkable case of exodontosis on record, is related by Mr. Fox. The subject was a young lady, who, at the time she came to Mr. F., had suffered so much and so long, that the palpebræ of one eye had been closed for near two months; and the secretion of saliva had, for some time, been so copious, that it flowed from her mouth, whenever opened. She had tried every remedy science and skill could suggest, without experiencing any permanent benefit, and was only relieved from her suffering by the extraction of every one of her teeth.

In the course of the author's practice, he has removed many teeth affected with exostosis, but has never met with a case similar to that described by Mr. F. In one instance, he was compelled to extract four sound teeth and nine roots; yet the pain was not at any time severe, but it was constant, and a source of great annoyance to the patient. The following is one among the many cases which have fallen under his observation:

Mr. S., of Baltimore, in the fall of 1845, called upon us for advice. Having for some time suffered pain in the first left superior bicuspid, he had applied two years before to a dentist,

for the purpose of having the tooth removed. In the operation, the root, about three-sixteenths of an inch from its extremity, was fractured and left in the socket. In consequence of this, the gnawing pain with which he had for a long time before been troubled, continued, and at the expiration of twelve months, the gum over the remaining portion of the root became very much swollen, puffing out the lip to the size of half a hen's egg. The tumor, after a few days, was opened, and a large quantity of dark-colored, fetid, purulent matter was discharged, which, for a short time, gave considerable relief. The tumor, however, was re-formed and opened some four or five times in as many months. At this time his gum was swollen, and the upper lip puffed out in the manner just described. On opening the tumor, about three table-spoonfuls of black matter, resembling thin tar, escaped. We then found, upon examination, that the outer wall of the antrum, immediately over the remaining portion of the root of the first bicuspid, was destroyed, and there was an opening through it large enough to admit the fore-finger. Believing that the extremity of the root left in the socket was the cause of the disease, we immediately proceeded to extract it, which we succeeded in doing after removing the outer wall of the alveolus. The root was found, on removal, to be enlarged by exostosis to the size of a very large pea. The operation proved perfectly successful, the secretion of purulent matter soon ceased, and in a few weeks he was completely relieved from the troublesome affection under which he had so long labored.

CAUSES.

The primary cause of this disease does not appear to be well understood. Most writers concur in attributing the proximate cause to irritation of the periosteum of the fang; but this is not, as some suppose, necessarily dependent upon any morbid condition of the crown itself, for it often attacks teeth that are perfectly sound. It seems rather to be attributable to some peculiar constitutional diathesis.

TREATMENT.

The disease having established itself does not admit of cure, and when it has progressed so far as to be productive of pain and inconvenience to the patient, the loss of the affected teeth becomes inevitable. When the enlargement is very considerable and confined to the extremity of the root, and has not induced a corresponding enlargement of the alveolus around the neck of the tooth, the extraction of the affected organ is often attended with difficulty, and can only be accomplished by removing a portion of the socket, or fracturing it.

CHAPTER FIFTEENTH.

SPINA VENTOSA OF THE TEETH.

Among the diseases which attack the teeth, Mr. Fox mentions spina ventosa, but the author thinks that the name is not strictly applicable to the affection of which he treats under that designation. This term in surgery is applied to an expansion of bone from a collection, in the broken down cancellated structure, of a fluid, generally purulent, sometimes dark-colored. It is caused by injury, or proceeds from cachexia and constitutional debility. It differs from osteosarcoma in not being malignant, also in not throwing out any fungous growth when the outer walls of bone give way.

Mr. Fox describes the disease as being seated in the cavity of the tooth; "the vessels ramifying on its membrane acquire a diseased action by which the membrane becomes thickened, absorption of some of the internal parts of the tooth takes place, and the opening at the extremity of the fang becomes enlarged. This disease of the membrane is attended with the formation of matter, discharging itself at the point of the fang, into the alveolar cavity, which, being rendered more porous by the process of absorption, affords an easy exit. During the progress of the disease, the gum covering the alveolar process becomes inflamed, and acquires a spongy texture; the matter, passing from the socket, makes its escape into the mouth by several openings through the gum, which is thus kept in a constant state of disease."

Now, it will be perceived, that there is little or no analogy between spina ventosa and the disease spoken of by Mr. Fox; which is nothing more than the result of alveolar abscess, arising from inflammation and suppuration of the lining membrane. When matter is confined in the cavity of the tooth, the canal in the root may become greatly enlarged. The author has met

with many cases where this has happened, and he has in his possession several specimens of teeth thus affected.

If, previously to the suppuration of the lining membrane and pulp, the tooth should be affected with exostosis, the disease would then bear some resemblance to spina ventosa, which is characterized by external enlargement of the bone; whereas, in the disease in question, the size of the root is seldom increased. The external appearance of the organ is that of a necrosed tooth.

CAUSES.

The enlargement of the opening at the extremity of the root, is not, as Mr. Fox believes, caused by the action of the absorbents; since before this takes place, the lining membrane has been destroyed, and the vital powers of the root are so much reduced as to preclude the possibility, even admitting that the absorbents are capable of effecting such enlargement, of its being accomplished through their agency. The enlargement is wholly attributable to the action of the corrosive matter contained in the root. This explanation appears the more probable when we consider that the matter discharged from the socket, is ichorous, offensive, and of an irritating character.

TREATMENT.

A tooth affected with this disease does not admit of cure. The proper treatment, therefore, consists in its prompt removal. There are no local nor general remedies which can be applied, capable of affording relief. The symptoms, perhaps, may sometimes be palliated; but it is not advisable to tamper with a tooth thus affected, as it will only serve to protract and ultimately to augment the evil.

It is possible that the occurrence of the affection might, in some cases, be prevented by prompt antiphlogistic treatment; such as is recommended for the prevention of necrosis, and for the cure of tooth-ache caused by inflammation of the lining membrane. But after suppuration has taken place, and a secretion of fetid and corrosive matter has been kept up until the canal of the root has become enlarged, the proper remedial indication is the removal of the tooth.

CHAPTER SIXTEENTH.

DENUDING OF THE TEETH.

THIS is one of the most remarkable affections to which the teeth are liable. It consists in the gradual wasting of the enamel on the labial surfaces, attacking first the central incisors, then the laterals, afterwards the cuspids and bicuspids, extending sometimes to the first and second molars. It usually forms a continuous horizontal groove, as regularly and smoothly constructed as if it had been made with a file. See Fig. 153. After

FIG. 153.

FIG. 154.

it has removed the enamel, it commits its ravages upon the subjacent dentine, sometimes penetrating to the pulp-cavity. It rarely changes the color of the enamel, but the dentine, after it becomes exposed, assumes first a light, and afterwards a dark-brown color; retaining, however, a smooth and polished surface. This destructive process does not always commence at merely one point on the labial surface of the central incisors, as just described; it sometimes attacks several points simultaneously. (See Fig. 154.) As it spreads, these unite, and ultimately a deep excavation is formed, with walls so smooth and highly polished that the tooth presents the appearance of having been scooped out with a broad, square, or round-pointed instrument.

The progress of the affection is exceedingly variable. It is sometimes so rapid that the dentine becomes exposed within two or three years from the commencement of the disease; at other times its effect upon the enamel is scarcely perceptible for the first six or eight years after it makes its appearance. In the case of a lady whose teeth were thus affected, the denuding process did not perforate the enamel for nearly twenty years. The

dentine, after it is denuded of enamel, is generally quite sensitive, and very susceptible to heat and cold.

CAUSES.

The cause of this singular affection has never been satisfactorily explained. It was first noticed by Mr. Hunter, who calls it decay by denudation, and supposes, that it is a disease inherent in the tooth itself, and not dependent on circumstances in after life: for the reason that it attacks certain teeth rather than others, and is often confined to a particular tooth.

Mr. Bell thinks Mr. Hunter has confounded this affection with another, similar in its appearance, but arising from a wholly different cause. Mr. Hunter states that he has seen instances where it appeared as if the outer surface of the dentine, which is in contact with the inner surface of the enamel, had first been lost, so that the cohesion between the two had been destroyed; and as if the enamel had been separated for want of support, for it terminates abruptly. Upon which Mr. Bell remarks: "Mr. Hunter describes very accurately the result of superficial absorption of the bony structure; a circumstance which I have occasionally seen, though more rarely than the present abrasion of the enamel, with which it cannot for a moment be considered as identical. In one case the enamel is gradually and slowly removed by a regular and uniform excavation; in the other, the abruptness and irregularity of the edges show that it had broken away at once, from having lost its subjacent support. The cause of the former is external; in the latter it is within the enamel."

Mr. Bell, in attempting to correct one error, has fallen into another, equally great and palpable. He attributes the breaking in of the enamel to absorption of the subjacent dentine, instead of ascribing it to decomposition by chemical agents, which is the true cause. In almost every instance, where the author has found the edges of the enamel in the condition described by Messrs. Hunter and Bell, he has also observed that the surface of the exposed dentine was decayed. But the breaking in of the enamel is not the affection now under consideration. That is the result of caries of the subjacent dentine; this, a sort of spontaneous abrasion.

Mr. Bell is unfortunate, also, in the suggestions which he throws out in regard to the cause of the disease. "Whatever may be the cause,—and at present I confess myself at a loss to explain it,—the horizontal direction in which it proceeds may, I think, be connected with the manner in which the enamel is deposited during its formation; for it will be recollected that it first covers the apex of the tooth, and gradually invests the crown by *successive circular depositions;* it is, therefore, not improbable that, from some temporary cause, acting during its deposition, certain circular portions may be more liable to mechanical abrasion, or other injury than the rest."

This conjecture, though it may seem somewhat plausible, is far from satisfactory. If, as he supposes, certain circular portions of the enamel are less perfectly formed than others, and consequently rendered more liable to the disease, it would not be wholly confined to the anterior surface of the tooth; but would extend entirely around it, and as soon as these imperfectly formed circular portions were destroyed, its ravages would cease.

Mr. Fox frankly acknowledges his inability to assign any cause for this affection; but conjectures that it is dependent upon some solvent quality of the saliva. Were this supposition correct, every part of the tooth would be alike subject to its attack.

Other writers suppose it is occasioned by the friction of the lips. But this hypothesis is destitute of the least semblance of plausibility; for the narrowness and depth of the grooves are sometimes such as to preclude the possibility of the contact of the lips with their surfaces.

Some eminent practitioners, again, attribute it to the use of tooth-brushes. That this may increase the size of the horizontal groove is more than probable; that it may even in some cases determine the commencement of the groove, is just possible. But no conceivable action of the brush could be an inciting cause of that form of the disease shown in Fig. 154. The true explanation must meet both cases. Hence the author has been led to adopt the opinion that the loss of substance which characterizes the affection is produced by the action of acidulated buccal mucus. In every other part of the mouth this fluid is mixed with saliva, and the acid it contains so much diluted as to pre-

vent it from acting on other portions of the teeth. Dr. E. Parmly reports a case, in which the natural teeth, set upon an artificial piece, were attacked in the same manner.

TREATMENT.

As a preventive, Mr. Fox recommends the avoidance of whatever tends to produce it, but unfortunately he leaves his readers entirely in the dark upon this subject. In advanced stages of the affection, the author has often succeeded in arresting its progress by widening the groove at the bottom, and afterwards filling it with gold. This, in the majority of cases, will prove successful. The patient should be cautioned against the use of stiff-bristled tooth-brushes; and should not, in using any kind, make too much movement across the front teeth, but rather up and down. Should the groove become discolored, it will be proper to use occasionally a little fine rotten-stone or prepared chalk on a small stick of some hard wood.

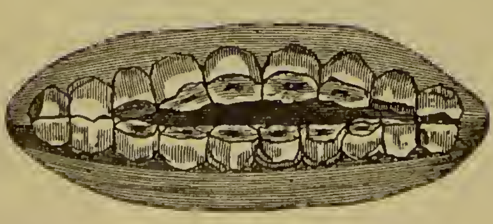
CHAPTER SEVENTEENTH.

SPONTANEOUS ABRASION OF THE CUTTING EDGES OF THE FRONT TEETH.

The spontaneous abrasion of the cutting edges of the front teeth is an affection of very rare occurrence. It commences on the central incisors; proceeding thence to the laterals, the cuspids, and sometimes, though very rarely, to the first bicuspids. Teeth thus affected have, when the jaws are closed, a truncated appearance; the upper and lower teeth do not come together, and they are rather more than ordinarily susceptible to the action of acids, or of heat and cold. In other respects, little or no inconvenience is experienced until the crowns of the affected teeth are nearly destroyed.

Its progress, as in the case of abrasion of the labial surfaces, is exceedingly variable. It sometimes destroys half or two-thirds of the crowns of the central incisors in two or three years; at other times seven or eight years are required to produce the same effect. In one case which came under our own observation, the abrasion had extended to the bicuspids; and the central incisors of both jaws were so much wasted, that on closing the mouth, they did not come together by nearly three-eighths of an inch; yet two years only had elapsed since its commencement. In another case, where it had been going on for seven years, it had not extended to the cuspids, and the space between the upper and lower incisors did not exceed an eighth of an inch. The subjects of these two were gentlemen—the first aged about twenty-eight, and the other twenty-one.

Fig. 155.



Mr. Bell gives an interesting case (Fig. 155) of a gentleman whose teeth were thus affected: "About fourteen months since (1831), this gentleman perceived that the edges of the incisors, both above and below, had become slightly worn down, and, as it were,

truncated, so that they could no longer be placed in contact with each other. This continued to increase and extend to the lateral incisors, and, afterward, successively, to the cuspids and bicuspids. There has been no pain, and only a trifling degree of uneasiness, on taking acids, or any very hot or cold fluids, into the mouth. When I first saw these teeth, they had exactly the appearance of having been most accurately filed down at the edges, and then perfectly and beautifully polished; and it has now extended so far, that when the mouth is closed, the anterior edges of the incisors of the upper and lower jaws are nearly a quarter of an inch asunder. The cavities of those of the upper jaw must have been exposed, but for a very curious and beautiful provision; they have become gradually filled by a deposit of new bony matter, perfectly solid and hard, but so transparent that nothing but examination by actual contact could convince an observer that they were actually closed. This appearance is exceedingly remarkable, and exactly resembles the transparent layers which are seen in agatose pebbles, surrounded by a more opaque mass. The surface is uniform, even, and highly polished, and continues, without the least break, from one tooth to another. It extends at present to the bicuspids, is perfectly equal on both sides, and when the molars are closed, the opening, by this loss of substance in front, is observed to be widest in the centre, diminishing gradually and equally on both sides to the last bicuspids."

CAUSES.

With regard to the cause of this most extraordinary affection, Mr. Bell, referring to the case which he describes, says, he is "wholly at a loss to offer even a conjecture. It cannot have been produced by the friction of mastication, for these teeth have never been in contact since the commencement of the affection; nor does it arise from any apparent mechanical cause, for nothing is employed to clean the teeth, except a soft brush. Absorption will equally fail to account for it; for not only would this cause operate, as it always does, irregularly; but we find that, instead of these teeth being the subjects of absorption, a new deposition of bony matter is, in fact, going on, to fill the pulp-cavities which would otherwise be exposed."

Mr. Bell is correct in supposing that it is not the result either of mechanical action or absorption. If, then, neither of these agencies are concerned in its production, it must be the result of some chemical action; though not of the salivary fluids of the mouth, for if so, every part of the exterior surfaces of the teeth would be acted on alike. This affection, as well as the one last noticed, the author is disposed to attribute to the action of acidulated mucus. The anterior surfaces of the upper front teeth not being so frequently washed by the saliva, the mucous secretions of the upper lip are often permitted to remain on these portions of the teeth for a considerable length of time; and to the presence of these, when in an acidulated condition, we believe the denuding process to be attributable; while the abrasion of the cutting edges of the incisors and cuspids is caused by an acid mucus, secreted from the mucous follicles of the end of the tongue, which is brought in contact with the cutting extremities of the front teeth almost constantly.

Dr. Nuhn, a German physician, describes a gland which he has recently discovered in the interior of the tip of the tongue. It is represented as having a number of ducts opening through the mucous membrane over it. It is thought to be a mucous gland, and it may be that this gland, in peculiar diatheses, secretes the acidulated mucus which may cause the affection under consideration. Be this hypothesis correct or not, it is evidently the result of the action of a chemical agent; and that this is furnished by the end of the tongue is rendered more than probable from the fact, that it is brought in contact with the cutting edges of the teeth, almost every time the mouth is opened.

TREATMENT.

If the tendency to an acidulated condition of the mucous secretions of the mouth could be overcome or counteracted, the progress of this affection of the teeth, perhaps, might be arrested. But the permanent cure of an obscure abnormal condition of any secretion is a tedious, difficult and often impossible thing. It may require hygienic and constitutional treatment, such as comes more within the province of the family physician than of the dentist. But we know of no treatment that will control or arrest this singular disease.

CHAPTER EIGHTEENTH.

MECHANICAL ABRASION OF THE TEETH.

Were it true, as declared by Richerand, that the loss of the enamel occasioned by friction is repaired by a new growth, it would never suffer permanent loss from mechanical abrasion. But enamel and dentine, once formed, pass beyond the sphere of that reparative power found in other bony tissues where red blood circulates freely. New enamel is therefore never formed after the eruption of the tooth; and new dentine only upon the surface of the lining membrane, which is exceedingly vascular.

The teeth rarely suffer loss of substance from friction when the incisors of the upper jaw shut in front of those of the lower. It is only when the former fall directly upon the latter, that mechanical abrasion of the cutting edges can take place, and when this happens, they sometimes suffer great loss of substance. The crowns of these teeth are occasionally worn entirely off, while those of the molars and bicuspids are, comparatively, little affected. The lateral motions of the jaw, being in these cases unrestricted—and this motion being of course greater at the anterior than at the posterior part of the mouth—it necessarily happens that the front teeth suffer the most abrasion. Sometimes all the teeth are worn off alike; at other times, owing to the peculiar manner in which the jaws come together, the abrasion is confined to a few.

Mr. Bell believes that certain kinds of diet tend, more than others, to produce abrasion of teeth: in proof of which he tells us that sailors, who, the greater portion of their lives, live on hard biscuits, have only a small part of the crowns of their teeth remaining. But the antagonism of the teeth has much more to do with it than the nature of the food; though of course when they do strike in such a way as to wear the cutting surfaces, very hard or gritty articles of food would make the abrasion more rapid.

When the front teeth of the lower jaw strike against the

palatine surface of those of the upper, the latter are sometimes worn away more than three-fourths, and in some instances entirely up to the gums. We have seen the teeth of some individuals so much abraded, in this way, that little of the crown remained, except the enamel on the anterior surface.

The wearing away of the crowns of the teeth would expose the lining membrane; were it not that Nature, in anticipation of the event, sets up an action by which the pulps are transformed into a substance called *osteo-dentine*, which is analogous in structure to cementum. By this beautiful operation of the economy, the painful consequences that would otherwise result are wholly prevented.

CHAPTER NINETEENTH.

FRACTURES AND OTHER INJURIES OF THE TEETH FROM MECHANICAL VIOLENCE.

THE injuries to which teeth are subject from mechanical violence, are so variable in their character and results, as to render a detailed description impossible. The same amount of violence inflicted upon a tooth does not always produce the same effect. The nature and extent of the injury will depend as much upon the physical condition of the teeth, the state of the constitutional health, and the susceptibility of the body to morbid impressions, as upon the violence of the blow. Thus, a blow sufficiently severe to loosen a tooth, might not, in one case, be productive of any permanent bad consequences; while in another, it might cause the death of the organ and inflammation of the adjacent parts, as well as necrosis of the alveolus.

A tooth of compact texture, and in a healthy mouth, may be deprived of a portion of its substance without any serious injury; but a similar loss of substance in a tooth not so dense in structure, would be likely to produce inflammation and suppuration of the lining membrane, and possibly of the alveolo-dental periosteum. Hence, in order to form a correct opinion of the result of injuries of this sort, we must take into consideration, not only the character of the tooth upon which the blow has been inflicted, but also the state of the mouth and the health of the individual.

If the tooth is not loosened in its socket, any injury resulting from the loss of a small portion of the enamel, or even of the dentine, may be prevented by smoothing the fractured surface with a file, that the juices of the mouth and particles of extraneous matter may not be retained in contact with it. But if the tooth is loosened, and inflammation of the investing membrane has supervened, leeches should be applied to the gums,

and the mouth washed several times a day with some astringent lotion, until the inflammation subsides.

When a tooth has been displaced from its soeket by a blow, and its vaseular eonneetion with the general system destroyed, neerosis must, as an almost neeessary eonsequenee, be the result. An imperfect union betwcen the tooth and alvcolus may sometimes be re-established by the effusion of coagulable lymph, and the formation of an imperfectly organized membrane; but the tooth will ever after, from the slightest eold, or derangement of the digestive organs, be liable to beeome sore to the toueh, and in most cases will ultimately assume a muddy-brown, unhealthy appearance.

The author has, on several oeeasions, replaeed teeth that had been knocked from their soekets; but in only two instanees was the operation attended with anything like sueeess. The subject in one ease was a healthy boy, of about thirteen years of age, who, while playing bandy, reeeived a blow from the elub of one of his playmates, whieh knocked the left central ineisor of the upper jaw entirely out of its socket. He saw the boy about fifteen minutes after the aceident. The alveolus was filled with eoagulated blood. This he sponged out, and, after having bathed the tooth in tepid water, carefully and aeeurately re-plaeed it in its socket, and seeured it there by silk ligatures attaehed to the adjaeent teeth. On the following day the gums around the tooth were eonsiderably inflamed, to reduee which inflammation he direeted the applieation of three leeches and the frequent use of diluted tincture of myrrh as a wash for the mouth. At the expiration of four weeks the tooth beeame firmly fixed in its socket, but from the effusion of eoagulable lymph, the alveolar membrane was thickened, and the tooth, in consequence, protruded somewhat. A slight soreness, on taking eold, has ever since been experieneed.

Dr. Noyes, of Baltimore, mentioned to the author a ease of a somewhat similar charaeter. The subject was a boy about ten years of age. One of his front teeth was foreed from its socket by a fall. It was replaced shortly after, and in a few weeks became firm in its alveolus. Mr. Bell also mentions a case attended with a like result.

The alveolar proeesses and jaw-bones are sometimes seriously

injured by mechanical violence. In 1834, the author was requested by the late Dr. Baker, of Baltimore, to visit, with him, a lady who, by the upsetting of a stage, had her face severely bruised and lacerated. All that portion of the lower jaw, which contained the six anterior teeth, was splintered off, and was only retained in the mouth by the gums and integuments, with which it was connected. The wounds of her face having been properly dressed, the detached portion of the jaw was carefully adjusted and secured by a ligature passed around the front teeth and first molars, and by a bandage on the outside, around the chin and back part of the head. Her mouth was washed five or six times a day with diluted tincture of myrrh. The third day after the accident Dr. Baker directed the loss of twelve ounces of blood; and, in five or six weeks, with no other treatment than the dressing of the wounds, she perfectly recovered.

It often happens that the crown of a tooth is broken off at the neck. We have known the crowns of four, and in one case of thirteen teeth to be fractured by a single blow. The subject of the last case was a fireman, who, in 1835, received an accidental blow on his mouth from the head of an axe, which broke off the crowns of all the upper and lower incisors, two cuspids, and three of the bicuspids of the inferior maxilla. The subject in the other case was a boy about twelve years of age, who, from a similar accident, occasioned by running up suddenly behind a man who was chopping wood, had the crowns of his upper incisors broken off. In both of these cases the inflammation which supervened was so great as to render the removal of the roots necessary. The crowns, fangs, and alveolar processes are sometimes ground to pieces, or the teeth driven into the very substance of the jaw. Mr. Bell says he once found a central incisor so completely forced into the bone, that he thought it to be the remains of a fang, but, on removing it, found it to be an entire tooth.

When the crown of a tooth has been broken off by a blow, the root should, as a general rule, be immediately extracted, because the injury it has received will seldom permit it to remain with impunity. We have sometimes engrafted artificial crowns on such roots, but the practice is usually a bad one. If the tooth

is to be replaced with an artificial substitute, the root should be first extracted: in some cases, however, the fang may be filled and a tooth set upon it, not by pivot, but attached to a plate.

But whether the loss of the crown be replaced or not, the root can seldom remain without injury, for after the inflammation induced by the concussion of the blow has sufficiently subsided, or terminated in suppuration of the lining membrane, which it usually does, it acts as a morbid irritant to the socket and adjacent parts, and for this reason should be removed.

CHAPTER TWENTIETH.

DISEASES OF THE DENTAL PULP AND PERIOSTEUM.

The pulp of a tooth, from the high degree of vitality with which it is endowed, is one of the most sensitive structures of the body, and like other parts is liable to become the seat of various morbid phenomena. Its susceptibility to morbid impressions is influenced by a variety of circumstances, such as temperament, habit of body, the state of the constitutional health, the condition of the hard structures of the tooth, etc. A cause, which under some circumstances would not be productive of the slightest disturbance, might, under others, give rise to active inflammation, with all its painful and disagreeable concomitants. Increased irritability (hyperæsthesia) may exist independently of any organic change, either in the pulp, dentine, or enamel. Examples are often met with in females during gestation; but it arises more frequently as a consequence of caries than from any other cause connected with the teeth. Even before the disease has penetrated to the central chamber of the organ, the pulp often assumes a most wonderful and marked increase of irritability, either from functional disturbance arising from decomposition of the dentine, impaired relationship between the two, or from being more exposed to the action of external deleterious agents. Impaired digestion, as well as a disordered state of other functions of the body, frequently produces the same effect.

The susceptibility of the pulp to impressions of heat and cold, and of acids, is always increased by heightened irritability. When this exists to any considerable degree, the mere contact of these agents with the tooth is often productive of severe pain, which, on their removal, usually, very soon subsides. The pulp, however, may remain in this condition for months, and even years, without becoming the seat of inflammatory action.

Preternatural sensibility of the dentine, whether in a sound or

partially decomposed state, augments very appreciably the irritability of the pulp. The sensibility of dentine is sometimes so much increased that the mere contact of any hard substance with a part which has become exposed by the destruction of a portion of the enamel, is often productive of severe pain. Impressions of heat and cold conveyed through the conducting medium of a metallic filling, or through a thin covering of dentine, as sometimes happens when a considerable portion of the tooth has been worn away, is also a very frequent cause of heightened irritability of the pulp. With its susceptibility thus increased, the impressions produced by these agents are often a source of irritation, and even of inflammation and suppuration, causing the death of the entire crown and inner walls of the root of the tooth. At other times, the irritation is only followed by slight increase of vascular action and an effusion of plastic lymph over the affected part of the pulp, which is gradually converted into *osteo-dentine;* and thus a barrier is interposed between it and the irritating agents.

IRRITATION.

The pulp of a tooth may become the seat of severe pain even when there is no inflammation. The slightest increase of vascular action, when this organ is in a preternaturally irritable condition, is productive of more or less irritation. The pressure of the slightly distended vessels upon the nervous filaments distributed upon it, at such times, is sufficient to cause great pain.

Impressions of heat and cold are conveyed more readily to the pulp when the dentine is in a morbidly sensitive condition, and when this is the case, they produce a more powerful effect.

The remedial indications of pain in a tooth arising simply from irritation of the pulp, consist in the removal of the primary and exciting causes. When produced by impressions of heat and cold conveyed to it through the conducting medium of a metallic filling and intervening supersensitive dentine, if the severity and continuance of the pain is such as to warrant the belief that it will give rise to inflammation, the filling should be removed and some non-conducting substance placed in the bottom of the cavity before replacing it. If this is done before inflammation

actually takes place, it will prevent subsequent irritation from these causes. It is worthy of remark, however, that the pain thus produced, is in proportion to the sensibility of the subjacent dentine. If this is destroyed previously to filling the tooth, their action upon the pulp will be as effectually prevented as by the interposition of a non-conducting substance. But in the application of agents for this purpose, there is danger of destroying the vitality of the pulp. The employment of them, however, is resorted to more frequently to prevent pain during the removal of caries than to relieve any subsequent irritation from impressions of heat and cold.

Arsenious acid, cobalt, chloride of zinc, chloroform, and the actual cautery have all been employed in the treatment of sensitive dentine.

The use of arsenious acid in dental practice, has hitherto been chiefly confined to the destruction of the vitality of the pulps of teeth, but it will also destroy the sensibility of the dentine, and thus enable the operator to remove, without pain, the semi-decomposed parts of a sensitive carious tooth, preparatory to filling. In employing it for this purpose, however, great care is necessary to prevent the destruction of the vitality of the pulp, and the injection of the vessels of the dentine. This is very liable to happen when applied to a tooth of a very soft texture, especially if in the mouth of a young person, and when the caries extends nearly to the pulp-cavity. The action of arsenic, through the intervening hard structures, on the pulp, would seem, in the first instance, to cause, in some way, the decomposition of the red globules of the blood; whereby a pinkish-purple tinge is imparted to the serous portion of this fluid, which is conveyed to every part of the dentine. It seems, also, to exert some peculiar action upon the microscopic vessels of this tissue; for the fluid which they circulate is now evidently everywhere effused from their coats and brought into direct contact with the earthy salts, coloring them so deeply as to impart to the crown of the tooth a pinkish or purple hue, distinctly seen through the translucent enamel covering. Three or four cases in which this has happened have occurred in the practice of the author.

But the application of arsenic to a tooth is not necessarily followed by this effect. It is only in young persons, and in teeth

of a very soft texture, that this is liable to occur, unless permitted to remain in the tooth for a long time. When it is used merely for the purpose of destroying the vitality of the surface of the dentine at the bottom of the cavity, preparatory to the introduction of a filling, and to prevent irritation of the pulp from impressions of heat and cold, it should never be permitted to remain more than two hours. At the expiration of this time it should be removed, and after thoroughly washing and drying the cavity, the filling may be introduced, without danger of subsequent irritation of the pulp or discoloration of the tooth. The thirtieth, fortieth, or even fiftieth part of a grain, with an equal quantity of sulphate of morphia, is sufficient to apply to a tooth. It should be put on a dossil of raw cotton or lint moistened with creosote, and placed directly upon the bottom of the cavity. After the arsenic has been applied, the cavity should be carefully filled with wax, mastic, or Hill's stopping, to prevent the possibility of its escaping into the mouth and to exclude the buccal fluids. When the cavity is on the approximal surface of the tooth, additional security may be obtained by passing a ligature of floss silk three or four times around it and tying. A small ring cut from the end of a tube of caoutchouc placed on the tooth is even better than a ligature of silk.

Dr. Arthur recommends the use of cobalt for destroying morbid sensibility of dentine. He has used it for several years, and believes it to be as certain in its effects as arsenious acid and less liable to injure the pulp of the tooth. It is the arsenic, however, with which the cobalt is combined that produces the effect; but he thinks that its union with the cobalt renders it less liable to be taken into the dentine by absorption, and as a consequence, less liable to produce a deleterious action upon the pulp. It is used in the form of a brownish-black oxyd, reduced to a fine powder, and applied to the tooth in the same manner as arsenious acid.

For the destruction merely of morbid sensibility in the solid structures of a tooth, chlorid of zinc, according to the author's experience, although somewhat less certain in its effects, is superior to any preparation dependent for its active properties upon the presence of arsenic. With this agent it rarely happens that more than five minutes are required to obtain the desired

effect. Although a powerful escharotic, it does not, as all arsenical preparations are liable to do, produce any deleterious effect on the pulp of the tooth. It is thought, however, in some cases to modify the texture of the dentine; and, in the opinion of some practitioners, so much so as to render it more easily acted upon by decaying agencies. When first applied, it excites a sensation of heat, followed by burning pain, but these soon subside, and on removing it from the tooth, the parts of the cavity with which it was in contact, will, in a large majority of the cases, be found totally insensible to the touch of an instrument. Dr. F. N. Seabury relates a case in which he applied it directly to the exposed pulp of an aching tooth. The pain, which at first was increased, soon subsided, and after removing the chlorid, the tooth was filled in the usual way, without inconvenience to the patient.

The chlorid may be applied directly to the cavity of a sensitive tooth, without being combined with any other substance, on a little raw cotton or lint; or it may be made into a paste by mixing it with an equal quantity of flour, the moisture which it absorbs from the atmosphere being sufficient for the formation of the paste; or it may be mixed with a little pure anhydrous sulphate of lime, in an impalpable powder, and then applied to the tooth. But before this is done, as much of the decomposed dentine as possible should be removed, and the application should be held firmly in contact with the part of the cavity upon which it is intended to act. This may be done by filling the cavity after it has been put in, with softened wax or raw cotton. The chlorid may remain in the tooth from five to ten minutes, or until the burning sensation produced by it ceases. A single application will generally suffice to destroy the sensibility of the walls of the cavity to a sufficient depth to enable the operator to remove any remaining portions of decayed dentine without pain, and to obtund the vitality of the floor of the cavity sufficiently to prevent the transmission of impressions of heat and cold to the pulp. A second, and even a third application, however, will sometimes be required. We have before referred to the local action of chloroform. It is brief in its effect, and calls for repeated application in a long operation, but has the advantage of being totally free from the possibly injurious action of arsenic, cobalt and oxyd of zinc.

The actual cautery was at one time much used and highly recommended by French dentists in the treatment of sensitive decayed teeth, but as the application gave rise, very often, to inflammation of the pulp, its use in England and America was long since laid aside.

Less potent agents, such as pulverized galls, tannic acid, &c., have been employed for the purpose of destroying morbid sensibility in teeth preparatory to filling, and sometimes with good results.

Having noticed the agents usually employed for destroying morbid sensibility in dentine, we will proceed to notice a few of the non-conductors of caloric that have been used for the accomplishment of the same object. Among the substances which have been employed for this purpose, are, *asbestos*, *gutta percha*, *Hill's stopping*, *cork* and *oiled silk*.

Asbestos, as a non-conductor of caloric, certainly possesses every desirable property, and is as indestructible in a tooth as gold. When used for this purpose, the purest variety should be selected. A small pellet, made from the filaments of this mineral, placed in the bottom of a cavity previously to filling, will effectually prevent irritation of the pulp from impressions of heat and cold. The cavity, however, should be first properly prepared, washed with tepid water and made perfectly dry. The asbestos may occupy from one-fourth to one-sixth of the depth of the cavity after the filling has been introduced and consolidated.

A thin layer of gutta percha placed in the bottom of the cavity, previously to introducing the gold, is as effectual in preventing the transmission of impressions of heat and cold, as asbestos, and can be more conveniently applied. There is, however, a preparation of it, known as "Hill's stopping," better than the simple article. The method of applying it is very simple. The cavity being first properly prepared, a small piece of this preparation is slightly warmed by a fire, or by the flame of a candle or lamp, then placed in the bottom of the cavity and adapted to its inequalities by pressing on it gently with a large broad-pointed plugger. This done, the cavity may be filled with gold in the usual manner.

Cork, though an equally good non-conductor of caloric, is

thought by some, as it is more destructible than asbestos or gutta percha, to be objectionable; but cut off, as it necessarily would be in the bottom of the cavity beneath the filling, its liability to undergo any change, would seem to be rendered wholly impossible. It is objected to its use, that it is of a more porous nature than gutta percha, and cannot be adapted as perfectly to the inequalities of the floor of the cavity. Also that there is danger in introduced the filling of forcing some portions of the gold through it, unless a very thick piece be used. Oiled silk has also been used in some cases very successfully, but it is not as good a non-conductor as any of the afore-mentioned agents.

But a metallic filling is not the only medium through which impressions of heat and cold are conveyed to the dental pulp. When the dentine on the coronal extremity or side of a tooth becomes very thin from loss of substance, occasioned by mechanical or spontaneous abrasion, by the use of the file, erosion, or other cause, the pulp sometimes becomes painfully susceptible to the action of these agents. Loss of substance from any of these causes, is also often attended by exalted sensibility of the exposed dentine; and when this is the case, the contact of acids with it is productive of more or less pain. Nature, however, usually prevents the painful consequences that would naturally arise from continued abrasion of the coronal ends of the teeth and the consequent exposure of their nervous pulp, by the gradual ossification of this organ; so that by the time it would become exposed, it is converted into osteo-dentine. But this does not always take place in time to prevent irritation and pain.

When irritation of the pulp occurs in a tooth that has been filed on one or both sides, so much so as to leave only a thin covering of dentine, the best known means of preventing morbid sensibility is, to keep the filed surface constantly clean by frequent friction, with a brush and waxed floss silk, or with some other suitable substance. This operation should be repeated after each meal, and in the morning immediately after rising, and at night before going to bed.

When caries has extended to the central cavity, irritation is often produced by contact of partially decomposed portions of dentine or other foreign matter with the pulp. The proper remedial indication in such cases, it is scarcely necessary to say,

consists in the removal of all matter from the tooth that can act either as a mechanical or chemical irritant. This done, the cavity in the tooth, supposing the pulp to be in a healthy condition, should be properly filled.

But when the irritation arises as a consequence of exalted irritability and increased vascular action of the pulp, dependent upon disease or altered function of some other part or parts of the body, the remedial indications are different. The treatment then should be addressed to the primary affection. Examples of this sort are of frequent occurrence. They are met with almost daily, particularly in females during gestation, in dyspeptic individuals, and in persons affected with gout and chronic rheumatism. They are also sometimes met with in individuals who have been exposed to miasmatic emanations of marshy districts, when the irritation assumes an intermittent form, occurring at stated intervals of twenty-four, forty-eight or seventy-two hours, and continuing from one to three hours. Some of the worst forms of tooth-ache are produced by one or other of these causes.

The local disturbance, when it occurs in females during pregnancy, may generally be removed by mild aperients, warm foot-bath and anodynes at night on going to bed. When it depends upon other kinds of derangement of the uterine organs, treatment suited to the peculiar indications of the case should be instituted. When it occurs in a person affected with dyspepsia, rheumatism or gout, the constitutional treatment required by the particular disease, constitutes the proper remedy. When the irritation assumes an intermittent form, an emetic or cathartic, followed by quinine, will generally put a stop to the local disturbance, provided it has no connection with caries of the crown of the tooth.

INFLAMMATION.

The pulp of a tooth, when healthy, has a grayish-white appearance, and its capillaries are invisible to the naked eye, but when it becomes the seat of *acute* or *active* inflammation, they may be distinctly seen; the organ then assumes a bright red color. Inflammation having established itself, soon extends to every part of the pulp, and even to the alveolo-dental periosteum. When permitted to run its course uninterruptedly, it usually terminates in suppuration in from three to eight or ten days.

The unyielding nature of the walls of the cavity in which it is, on all sides, enclosed, renders expansion of the pulp impossible, and as its capillaries become distended with blood, they press on the nervous filaments which are everywhere distributed upon it, causing at first constant gnawing pain; which afterward, as the distension of the vessels increases, becomes severe, deep-seated, throbbing, and sometimes almost insupportable.

Inflammation may attack the pulps of sound teeth as well as those affected with caries; but it occurs more frequently in the latter than in the former, and it is oftener met with before than after the pulp has become actually exposed. The severity of the pain, however, is determined by the condition of the tooth, the state of the general health, and the causes concerned in its production. The pulp, when in an irritable condition, is more liable to become the seat of acute inflammation, than when in a perfectly healthy state, and the occurrence of suppuration is soon followed by alveolar abscess, unless an opening is made immediately through the crown, neck or root of the tooth, for the escape of the matter.

The effusion of lymph which takes place during the inflammatory stage, and which, under other circumstances, and when the inflammation is less severe, is made to play an important part in the reparation of the injury, compresses the pulp into still narrower limits as it accumulates in quantity, and thus becomes an additional source of irritation, adding fuel to the flame already lighted up.

Inflammation of the pulp may be caused by a blow on the tooth; by impressions of heat and cold conveyed to it through the enamel and dentine, or through a metallic filling; or by the pressure of a filling, or the direct contact of external irritating agents, such as, disorganized portions of the tooth, particles of alimentary substances, acrid humors, etc. But, as we have stated in another place, *inflammation* of the dental pulp is not always a necessary consequence of impressions of heat and cold; pain may be produced by them when it does not exist, but in this case it usually subsides soon after the removal of the irritant. The pulp of a tooth may be exposed for months, and subjected several times a day to the actual contact of foreign bodies, without becoming the seat of acute inflammation. The

irritation and increased vascular action thus occasioned, are, no doubt, removed by the effusion of lymph to which they give rise, and the pulp, after it has become exposed, having room to expand as its vessels become distended, does not suffer irritation from the pressure to which it would otherwise be subjected.

When suppuration takes place, the pain very nearly ceases, but the tooth for a time remains sore to the touch, and its appearance is changed. It has no longer the peculiar animated translucency of a living tooth, but has assumed an opaque, muddy or brownish aspect. With the disorganization of the pulp, the entire crown and inner walls of the root lose their vitality; still, if the alveolo-dental periosteum has not become seriously involved in disease, the vascular and nervous supply furnished to the cementum is often sufficient to prevent the tooth from exerting any injurious influence upon the surrounding and more highly vitalized parts. The cementum being more analogous in structure to true osseous tissue than dentine, now plays an important part in the animal economy. It being more liberally supplied with vitality and with nutritive juices, and not being sensibly affected by the death of the other parts of the organ, it keeps up the living relationship of the tooth with the alveolo-dental periosteum, at least sufficiently to prevent it from acting perceptibly as a morbid irritant.

Inflammation of the pulp of a tooth, besides the local pain with which it is attended, often gives rise to a train of constitutional morbid phenomena, usually of a mild, but sometimes of an aggravated and even threatening character. Among these are *head-ache*, *constipation of the bowels*, *furred tongue*, *dryness of the skin*, *quick*, *full* and *hard pulse*, *ear-ache*, *ophthalmia*, *disease of the maxillary sinus*, etc.

The amount of constitutional disturbance arising from inflammation of the pulp of a tooth, depends on the state of the general health, and the nervous irritability of the system at the time. In the majority of cases it occasions but little inconvenience, and disappears as soon as the inflammation ceases, but sometimes it assumes a very alarming character. A fatal case of tetanus, produced by inflammation of the pulp of a lower molar, occurred a few years ago in Baltimore. The subject was a young lady about eighteen years of age. The system, at the

time, from great bodily fatigue and mental excitement, was in an exceedingly irritable condition, but in other respects, though constitutionally rather delicate, she was in the enjoyment of good health.

There is not an organ or tissue of the body in which acute inflammation is more intractable in its nature, and rapid in its progress, than in the pulp of a tooth; and, when we take into consideration its situation, and its physical and vital peculiarities, it is not to be wondered that it should, in so large a majority of the cases, terminate in the disorganization of the part. Still, it may sometimes be arrested, and the remedial indications here, though they cannot be as readily and fully carried out, are the same as for inflammation in any other part of the body. The first and most important one consists in the removal of all local and exciting causes. If it be the result of irritation produced by the pressure of a filling, the plug should be immediately removed, leeches applied to the gum of the affected tooth, and, if the patient be of a full habit, blood may be taken from the arm, and a brisk saline purgative prescribed. The removal of the filling, however, when the inflammation has previously made much progress, will not prevent suppuration, but it may keep it from extending to every part of the pulp. When an external opening is made for the escape of the matter the moment suppuration takes place, the remaining portion of the pulp will be relieved from the pressure which caused the irritation, and then the inflammatory action may cease. But if the matter remains in the central cavity of the tooth, the part of the pulp which has not suppurated will still be subjected to pressure, and the inflammation and suppuration will go on until the entire organ perishes. Nor will the disorganizing process stop here. The alveolo-dental membrane, at the extremity of the root, will soon become implicated, and in a short time alveolar abscess will form, thus terminating the acute stage of the disease.

There may be no indications of irritation or inflammation for several weeks, or even months, after a tooth has been filled; but at the expiration of this time, the pulp, from increased irritability, caused, perhaps, by some change in the state of the patient's general health, may be attacked by inflammation.

Although this very seldom happens, it does, nevertheless, sometimes occur. When there is reason to apprehend that it is about to take place—and it may be suspected if pain is felt in the tooth when anything hot or cold is taken into the mouth, or if it becomes the seat of gnawing or gradually increasing pain—the filling should be removed. If the pain now ceases, a thick layer of gutta percha, or "Hill's stopping," may be placed in the bottom of the cavity, and the filling replaced; using the precaution, as before directed, to introduce the gold in such a way as to prevent the liability of depressing the floor of the cavity. But if the pain and inflammation continue unabated, it may be necessary to extract the tooth, or expose the pulp and destroy its vitality by applying to it some powerful escharotic, as arsenious acid; which, acting more promptly and with more certainty than any other, seems best adapted to the purpose. When this is done, it is usually with the view of securing the retention and preservation of the tooth by filling the pulp-cavity and root, an operation now very frequently performed by many dentists.

The abstraction of blood directly from the pulp, one might suppose, would be better calculated to arrest the inflammation than almost any other treatment; but we do not think this has been resorted to for this purpose sufficiently often to determine its therapeutic value. At any rate, it seems reasonable to suppose that if, by this means, the congestion of the capillaries could be removed, the tumefied pulp would be reduced to its natural size, and be relieved from the pressure to which, as a consequence of its distended condition, it is subjected. To obtain the largest amount of benefit capable of being derived from the operation, the opening should be made in that portion where one of the principal arteries would be most likely to be punctured; and this, it seems to us, would be just where the canal of the root enters the chamber of the crown of the tooth. But in making the puncture here, the pulp being very small at this point, there is danger of cutting it off; and as reunion would scarcely be likely to take place, the portion in the central cavity would necessarily perish.

If the pulp were exposed, there would be a better opportunity of relieving the congested condition of its capillaries by the abstraction of blood; but the difficulty of obtaining free access to

the organ by drilling a hole through the intervening dentine is very great; the tooth, when suffering from inflammation, being usually so sore to the touch that the slightest pressure is productive of great pain; hence, the operation will seldom if ever prove successful. Unless, therefore, the retention of the tooth is a matter of more than ordinary importance, it is better to remove it at once. If it is an incisor or cuspid, the pulp should be immediately extirpated or arsenious acid applied for the destruction of its vitality; or, if suppuration has previously taken place, an opening should be made into the chamber of the tooth as before directed, for the escape of the matter. Should it be found, after this has escaped, that disorganization has not extended to every part of the pulp, the remaining portion may be destroyed in the manner above described. This done, the pulp-cavity and root, as soon as the inflammation of the socket has completely subsided, may be filled.

It will be seen from the foregoing remarks, that it is only at its very inception, that there is any chance of combating successfully acute inflammation of the pulp of a tooth; and even then, so rapid is the progress of the disease, it may baffle the best directed and most energetic treatment, that can be adopted. It may be that when attention shall have become more generally directed to the subject, some more successful method of treatment may be discovered; but that a complete mastery over the disease will ever be obtained, is not to be expected.

Inflammation of the dental pulp is not always acute; it sometimes assumes a chronic and local form. This often occurs where the chamber of a tooth has become gradually exposed by caries of the dentine; and when this happens, the action of the fluids of the mouth, and of other foreign substances which obtain access to the cavity, as well as of the decomposed portions of the tooth substance, causes an increase of vascular action in the exposed part, followed, very often, by a slight discharge; but the morbid action thus induced is, comparatively, seldom accompanied by pain. The pulp may remain thus partially exposed for months, and even years, without causing any other inconvenience than a momentary twinge of pain when some hard substance is accidentally introduced into the cavity of the tooth, which subsides immediately after its removal. Sooner or later,

however, the pain thus excited will become more permanent, continuing each time it occurs, from five or ten minutes to one or more hours after the cause of the irritation has been removed. If a tooth be filled under such circumstances, the pressure of the fluid upon the pulp, which is poured out from its exposed surface beneath the plug, will give rise to a more general and active form of inflammatory action.

The liability of the tooth to ache increases as the pulp becomes more and more exposed by the gradual decomposition of the dentine ; and the inflammation may ultimately assume a more active form, or the pulp may become the seat of fungous growth, or it may be absorbed or destroyed by ulceration, or by gangrene and mortification. Cases sometimes occur in which the disease is attended with severe darting pains, often occurring several times in the space of two or three minutes, succeeded by intervals of perfect ease for many hours. At other times it is attended by dull aching pain, aggravated by taking sweet or acid substances into the mouth. In cases of this sort, the application of heating or stimulating substances to the exposed surface of the pulp will usually procure relief. Permanent exemption from pain, however, is rarely obtained, and sooner or later, it becomes necessary either to destroy the pulp or to extract the tooth.

The body of the pulp when the organ becomes exposed from a decayed opening in the grinding surface of a molar, is sometimes absorbed, while its prolongations in the roots often remain unchanged for two or more years.

Chronic inflammation of an exposed surface of the pulp, when long continued, sometimes gives rise to *ulceration*—a disorganizing process, which often causes the destruction of a large portion of the part occupying the central chamber of the crown of the tooth, making in it numerous little excavations. The ulcerated surface usually presents a yellowish appearance ; when the disorganizing process is arrested before it has effected the destruction of any very large portion of the pulp, it usually becomes covered with healthy granulations.

When the inflammation occurs in cachectic individuals it often assumes an acute form, and sometimes terminates in gangrene and mortification. The loss of vitality may be confined to the body of the pulp, or it may extend to every part of the organ.

In the former case the pain continues, but in the latter it ceases as soon as mortification takes place. When this happens, the entire pulp, which has now a dark brown or black color, may be removed. But this is not a very common termination.

The symptoms of chronic as well as acute inflammation are always modified by the state of the general health, habit of body, and the temperament of the individual. The pain attending the former, however, is periodical, occurring at irregular and uncertain intervals, and constitutes that variety of tooth-ache so often relieved by local applications; whereas, in the latter, it is constant.

In chronic inflammation, the pulp is either actually exposed or only covered by decomposed or partially decomposed dentine, and the diseased surface rarely embraces a larger circumference than that described by the bottom of the decayed cavity. The inflammation, therefore, is local as well as chronic, but, nevertheless, it is often of so persistent a character, as to render its removal exceedingly difficult. The dentist, however, is not so much restricted in the application of remedies as in the treatment of acute inflammation, and to the action of which it yields more readily. But notwithstanding all this, he will necessarily encounter difficulties in his efforts to subdue it. A greater length of time is sometimes required than the patient is willing to give; and the opening through the crown to the central cavity is frequently too small, previously to the removal of the partially decomposed dentine, to admit of the direct application of the necessary remedial agent to the inflamed surface of the pulp. Again, it often happens, that the situation of the tooth and cavity are such as to prevent a complete view of the diseased part. It is important that the operator should get such a view to enable him to determine whether the inflamed surface is ulcerated, or pours out a serous fluid; or whether the morbid condition is simply one of irritation, produced by the presence of acrid matter, or of partially or wholly decomposed dentine. Unless his diagnosis is correct, his prescription will be as likely to do harm as good: but, having ascertained the exact character of the disease, he may often be able to institute treatment that will result in the restoration of the pulp and the preservation of the tooth.

It is important, too, to understand the part which nature plays

in the curative process; for cure here, as in other parts of the body, is effected by that internal force, which, as Chomel says, "presides over all the phenomena of life, contends unremittingly with physical and chemical laws, receives the impression of deleterious agents, reacts against them and effects the resolution of disease." This vital force is sometimes exercised in the cure of disease in the pulp of a tooth, but more frequently in its prevention; as is shown by the gradual ossification of the organ in those cases where it would otherwise become exposed by mechanical or spontaneous abrasion of the solid structures which enclose it; and occasionally by the formation of secondary dentine upon the surface of the original or primary dentine at a point toward which the caries is advancing. Nature, no doubt, would always provide in this way against the exposure of the pulp, if the occurrence were always long enough preceded by sufficient irritation or increase of vascular action in it to call her energies into operation. But the formation of osteo-dentine, which constitutes the protective wall of defence, is a tardy process, and as a general rule, proceeds more slowly than the caries in the tooth, which causes the exposure of the pulp. Besides, it often happens that its approach is not announced by the slightest irritation, a condition necessary to the new formation, until it reaches the central cavity. At other times, the approach of the disease gives rise to too much irritation, a condition equally unfavorable to the dentinification of the pulp. Thus, no protective covering being formed, it soon becomes exposed, when it is subjected to the action of such irritating agents as may chance to be brought into contact with it. Hence, its liability to become the seat of chronic inflammation as well as other forms of diseased action.

If the disease is attended with pain, the removal of this must first claim attention, and should be effected with as little delay as possible; otherwise the morbid action may extend to every part of the pulp and peridental membrane, and assume a more active and unmanageable form. If the pain is the result of irritation produced by the direct action of mechanical or chemical agents, the cavity in the tooth should at once be carefully freed from all extraneous substances and decomposed portions of dentine. This done, a dossil of raw cotton or lint—saturated with

spirits of camphor, laudanum, sulphuric ether, chloroform, creosote, or some one of the essential oils—may be applied. Immediate relief is sometimes obtained by an application of this sort. Counter-irritants have sometimes been used with advantage. The pain has often been removed by exciting increased secretion of saliva, but when a sialagogue is used, the cavity in the tooth should be filled with raw cotton or lint to prevent the agent from being brought in contact with the exposed surface of the pulp. But a remedy which will relieve the pain in one case often aggravates it in another.

When the irritation is produced by acidulated buccal fluids, the application of carbonate of soda or some other alkali, will often give immediate temporary relief; but as the condition of the secretions of the mouth, especially the salivary, is usually owing to gastric derangement, the correction of this constitutes the first and most important remedial indication. When any application is made to the pulp for the purpose of removing irritation and pain, its full effect will not be obtained unless the fluids of the mouth are excluded from the cavity of the tooth; this may be done by closing the orifice with softened wax or mastic, using the precaution not to force it in so far as to press the application previously made, upon the exposed pulp.

Until within the last three or four years, the writer did not believe it possible to preserve the vitality of a tooth by filling, after the pulp had become the seat of chronic inflammation, but he is now convinced that it can be done in very many cases, after a proper preparatory treatment, which often requires several weeks.

SPONTANEOUS DISORGANIZATION.

The spontaneous destruction of the pulp of a tooth is an affection which seems to have been entirely overlooked by writers on dental pathology; and, although it is one which rarely occurs, examples of it are met with sufficiently often to entitle it to a place among the diseases of the teeth. The first case which attracted the attention of the author occurred in 1836, and he has subsequently met with six or seven others. In each of them the disorganization had been carried on so insidiously, that neither

the presence of disease nor structural alteration was suspected, until the teeth had assumed a dull brownish or bluish-brown appearance. The death of the pulp had not been preceded in any of these cases by the slightest indication of inflammatory action. It had, apparently, resulted from want of sufficient vital energy to sustain the nutritive function.

The sockets of the affected teeth, in these cases, were, seemingly, in a healthy condition—a circumstance which, when we take into consideration that the parts of the extremity of the roots were exposed to the action of the disorganized remains of the dental pulps, may appear somewhat strange. But this may have been owing, partly, to diminished excitability in the alveolo-dental periosteum, and partly to the smallness of the quantity, and the innocuous character of the matter contained in the central cavities of the teeth. The gums of that portion of the alveolar border occupied by the affected teeth had a pale, grayish-purple appearance, but exhibited no indications of actual disease. They were as thin and their margins as distinctly festooned here as in any other part of the mouth. In some instances, the teeth had been in this condition for seven or eight years. On perforating the crowns, only a drop of dark brown matter, about the consistence of thin cream, and having but little odor, escaped from the pulp-cavity of each.

In all the cases which the author has seen of this remarkable affection, the loss of vitality had taken place previously to the twentieth year of age, and, according to his observations upon the subject, it seldom confines itself to a single tooth, but occurs simultaneously in corresponding teeth. The pulps of several usually perish at about the same time. In the first case to which his attention was called, six had lost their vitality. The affection, too, seems to be principally confined to the incisors and cuspids, and sound teeth appear to be as subject to it as those which are carious.

Now, as the disorganization of the pulp, in cases of this sort, is not the result of inflammatory action, it must be dependent upon constitutional rather than local causes—upon some peculiar cachexia, which causes the function of sanguinification to be imperfectly performed. This inference, too, seems to be fully warranted by the appearance of the subjects in all the cases

which the author has had an opportunity of examining—characterized by an extremely pale and slightly bloated aspect of countenance, indicating a serous condition of blood.

The remedial indications in cases of this sort are the same as in necrosis produced by inflammation and suppuration of the lining membrane and pulp.

FUNGOUS GROWTH.

The pulp of a tooth, when exposed by decay of the crown, sometimes becomes the seat of a fungous growth, in the form of a small vascular tumor. These morbid growths sometimes attain the size of a large pea, completely filling the cavity made in the crown of the tooth by decay; at other times they do not exceed that of a small elderberry. The former have little sensibility, and bleed freely from the slightest injury; the latter are less vascular, but are nearly as sensitive as the pulp in a healthy state.

It often happens that a fungous growth of the gum or dental periosteum, finding its way through an opening in the side of the neck or root of a decayed tooth, appears in the central cavity, and is sometimes mistaken for a morbid growth of the pulp. Such tumors usually grow very fast, and sometimes attain the size of a hickory nut. They are exceedingly vascular, bleeding profusely when wounded, and are soon reproduced after removal. The author has met with tumors of this kind which had originated in the alveolo-dental periosteum of the extremity of the root.

The only remedy in such cases is the removal of the tooth. A cure cannot be effected by extirpating the morbid growth. The author has frequently removed them nearly to the extremity of the root, but they have always reappeared in a few days or weeks after the operation. Even if a return of the disease could be prevented, the extraction of the tooth should be insisted on, as all teeth in which tumors of this sort are situated, are morbid irritants, and cannot remain without detriment to the health of the parts with which they are in immediate connection.

OSSIFICATION.

Allusion has been made, several times, in the course of this work, to the ossification of the dental pulp, as a means employed by nature to prevent the exposure of this most delicate and exquisitely sensitive structure. But examples of it are occasionally met with in teeth which have suffered no loss of substance, either from mechanical or spontaneous abrasion, or from the decay of the dentine. The occurrence, whatever may be the circumstances under which it takes place, is evidently the result of the operation of an established law of the economy, dependent upon moderate irritation and a slight increase of vascular action; ossification having commenced, it usually goes on until every part of the pulp is converted into a substance analogous to cementum. We infer, then, that when the pulp of a tooth becomes the seat of a sufficient amount of irritation, ossification must follow as a necessary consequence; but if the irritation be succeeded by active inflammation, a different result may be expected.

The irritation necessary for the ossification of the pulp of a tooth sometimes arises from constitutional causes; but in the majority of cases, it results from the action of local irritants, and most frequently from impression of heat and cold, communicated through the medium of a metallic filling or a thin layer of dentine.

During the ossification, a sensation is occasionally experienced in the tooth somewhat similar, though altogether less in degree, to that which attends the knitting of the fractured extremities of a broken bone. A numb, vibratory pain, barely perceptible, is felt passing through the tooth several times a day, but only lasting a second or two at a time. It is scarcely sufficient to occasion any annoyance, or to attract anything more than momentary attention.

With the ossification of the pulp, the crown and inner walls of the root lose their vitality, but the appearance of the tooth is not, as in the case of necrosis arising from the disorganization of the pulp, materially affected. The central cavity being filled with semi-translucent osteo-dentine, the crown retains its natural

color. The discoloration and opacity attending necrosis produced by other causes, result, partly from the presence of putrid matter in the pulp-cavity, and partly from its absorption by the surrounding dentinal walls.

INFLAMMATION OF THE DENTAL PERIOSTEUM.

Inflammation of the periosteum of a tooth may be *acute* or *chronic*, each variety being modified in its character both by the state of the constitutional health and by the causes concerned in its production. The acute variety, when left to itself, usually terminates in alveolar abscess, the suppurative process sometimes extending to nearly every part of the periosteum, causing the entire death of a tooth, and often followed by erosion of the root, and necrosis of the alveolus. When favored by a cachectic habit of body, it often extends to the periosteum of the jaw, followed by suppuration and necrosis. The following case will give some idea of the severity which it occasionally assumes.

In 1840, a poor girl, aged fourteen, was brought to the author. About three months before, she had been taken to a barber tooth-drawer for the purpose of having the first left inferior molar extracted. The crown was broken off, the roots left in the socket. Inflammation supervened. This soon extended to the periosteum of the entire bone from the second bicuspid to the coronoid process; as it was permitted to run its course uninterruptedly, it terminated in necrosis and exfoliation of all this portion of the bone (Fig. 156), the anterior extremity of which, when first seen by the author, had passed through the integuments of the lower part of the face, and protruded externally. A few days after, it was removed without difficulty.

FIG. 156.

As the causes, symptoms and remedial indications of acute inflammation of the dental periosteum were briefly described in the chapter on tooth-ache, and as we shall have occasion to refer to the subject again when we come to treat of alveolar abscess,

it will not be necessary to dwell upon it here. We shall merely state, however, that, after having terminated in suppuration, it sometimes, instead of subsiding altogether, degenerates into a chronic form, and when favored by some constitutional vice, as the scorbutic, venereal, or scrofulous, it often gives rise to the destruction of the socket and loss of the tooth.

Chronic inflammation of the dental periosteum, is not always preceded by the active form of the disease, but may assume this form at the commencement. In this case it is complicated with tumefaction of the gums, and discharge of puriform matter from between their edges and the necks of the teeth. For the treatment of this variety, the reader is referred to chronic inflammation and tumefaction of the gums.

CHAPTER TWENTY-FIRST.

DISLOCATION OF THE LOWER JAW.

From the peculiar manner in which the inferior maxilla is articulated to the temporal bones, it is not very liable to dislocation. When it occurs in one or both of the condyles, the luxation is always forward: the conformation of the parts preventing it from taking place in any other direction. The oblong, rounded head of each condyle is received into the fore part of a deep fossa in the temporal bone, situated just before the meatus auditorius externus, and under the beginning of the zygomatic arch. The articular surface of each is covered with a smooth cartilage, and between them there is a movable cartilage. This latter is connected with the articulating surfaces of the condyle and glenoid cavity, externally by the external lateral ligament, internally by the capsular ligament, and in front by the tendon of the external pterygoid. This cartilage is sometimes called the meniscus, from its shape, being thickest around its circumference, especially at the back part. The temporo-maxillary articulation is strengthened by an internal, an external and a capsular ligament: also by the tendinous and muscular insertions of the masseter, temporal and pterygoid muscles. The intervening movable cartilage, being more closely connected with the head of the condyle than with the glenoid cavity, escapes with the former. whenever dislocation of the jaw takes place.

Dislocation of the lower jaw is rarely caused by a blow, unless given when the mouth is open; it is more frequently occasioned by yawning or laughing. It has been known to occur in the extraction of teeth, and in attempting to bite a very large substance. Sir Astley Cooper mentions the case of a boy who had his jaw dislocated by suddenly putting an apple into his mouth to keep it from a playfellow.

After the jaw has been dislocated once, it is always more liable to this accident; consequently Mr. Fox very properly recommends

to those with whom it has once happened, the precaution of supporting the jaw whenever the mouth is opened very widely in gaping, or for the purpose of having a tooth extracted. None of these causes would be sufficient to produce the accident, unless the ligaments of the temporo-maxillary articulation are very loose, and the muscles of the jaw much relaxed.

The author witnessed a case of dislocation of the lower jaw in which the displacement occurred during an attempt to extract the first right inferior molar. The patient was a young lady from Virginia, about seventeen years of age. Both condyles were luxated, but so completely were the muscles of the jaw relaxed, that he immediately reduced it without the least difficulty; and afterward, by supporting the jaw with his left hand, succeeded in removing the tooth.

When the lower jaw is dislocated, the mouth remains wide open, as seen in Fig. 157, and a great deal of pain is experienced; this, according to Boyer, is caused by the pressure of the condyles on the deep-seated temporal nerves, and those which go to the masseter muscles, situated at the root of the zygomatic process. The condyles, having left their place of articulation, are advanced before the articular eminences and lodged under the zygomatic arches. The jaw cannot be closed; the coronoid processes may be felt under the malar bones; the temporal, masseter and buccinator muscles are extended; the articular cavities being empty, a hollow may be felt there; the saliva flows uninterruptedly from the mouth, and deglutition and speech are either wholly prevented, or very greatly impaired. Boyer says, that during the first five days after the accident, the patient can neither speak nor swallow. The jaw, when only one condyle is displaced, is forced, more or less, to one side.

Fig. 157.

If the dislocation continues for several days or weeks, the

chin gradually approaches the upper jaw, and the patient slowly recovers the functions of speech and deglutition. We are told by Mr. Samuel Cooper, that it may prove fatal if it remain unreduced;* but Sir Astley Cooper says, he has never known any dangerous effects to result from this accident; on the contrary, after it has continued for a considerable length of time, the jaw partially recovers its motion.†

In the reduction of dislocation of the lower jaw, the older surgeons employed two pieces of wood, which were introduced on each side of the mouth, between the molar teeth; while these were made to act as levers for depressing the back part of the bone, the chin was raised by means of a bandage.

The method usually adopted by modern surgeons for reducing a dislocation of this bone, consists in introducing the thumbs, wrapped in a napkin or cloth, (to prevent them from being hurt by the teeth,) as far back upon the molars as possible; then depressing the back part of the jaw, and at the same time, raising the chin with the fingers. In this way the condyles are disengaged from under the zygomatic arches, and made to glide back into their articular cavities. But the moment the condyles are disengaged, the thumbs of the operator should be slipped outward between the teeth and the cheeks; as the action of the muscles, at this instant, in drawing the jaw back, causes it to close very suddenly, and with considerable force. This precaution is necessary to avoid being hurt, unless a piece of cork or soft wood has been previously placed between the teeth.

By the foregoing simple method the dislocation may, in almost every case, be readily reduced; but Mr. Fox mentions a case in which it failed. The subject was a lady whose lower jaw had been luxated several times before; this time the accident was occasioned by an attempt which he made to extract one of the inferior dentes sapientiæ. After having failed to reduce the luxated bone by the usual method, he "happened to recollect a statement made to him by M. de Chemant, who having been frequently applied to by a person in Paris who was subject to this accident, had always succeeded in immediately reducing the luxation, by means of a lever of wood, as recommended by

* Surgical Dictionary, p. 306.

† A. Cooper on Dislocations, p. 389.

Dr. Monroe." Profiting by this statement, Mr. Fox procured a piece of wood about an inch square, and ten or twelve inches long. He placed one end of this upon the lower molars, and then raised the other, so that the upper teeth acted as a fulcrum. As soon as the jaw was depressed, the condyle of the side upon which the wood was applied, immediately slipped back into its articular cavity. The wood was then applied to the opposite side of the jaw, and the other condyle reduced in the same manner.*

The method proposed by Sir Astley Cooper, consists, when both condyles are displaced, in introducing two corks behind the molars, and then elevating the chin. He, however, first places his patient in a recumbent posture ;† but this is seldom necessary. The reduction of the dislocation can be as conveniently effected with the patient in a sitting as in a recumbent posture.

After the reduction of the dislocation, the patient is recommended to abstain for several days from the use of solid aliments, and to wear a four-tailed bandage ;‡ or, what is still better, the bandage contrived by Mr. Fox, (Fig. 74) to prevent its recurrence in the extraction of teeth. When this bandage is used for the latter purpose, the mouth is first opened to the proper extent, with the condyles in their articular cavities ; it is then applied, and the straps tightly buckled. This done, it is impossible to advance the jaw sufficiently to produce a dislocation.

* American edition of Fox on the Human Teeth, p. 330.

† A. Cooper on Dislocations, p. 391.

‡ Cooper's Surgical Dictionary, p. 306.

PART FOURTH.

SALIVARY CALCULUS.

DISEASES OF THE GUMS AND ALVEOLAR PROCESSES, AND THEIR TREATMENT.

PART FOURTH.

CHAPTER FIRST.

SALIVARY CALCULUS.

The physical characteristics, and the local and constitutional indications of salivary calculus, having been noticed in a preceding chapter, it will not be necessary to refer to them again. We shall, therefore, confine our remarks chiefly to its elementary constituents, its origin, the manner of its formation, its effects, and the removal of it from the teeth.

Tartar or salivary calculus sometimes accumulates in very

Fig. 158.

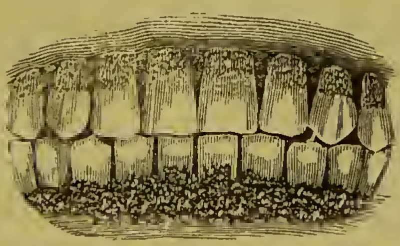


Fig. 159.

large quantities, giving to the mouth a most disagreeable and repulsive aspect, and imparting to the breath, not unfrequently, an almost insufferably offensive odor. Fig. 158 represents a set of teeth encrusted with it, and Fig. 159 a single tooth, presented to the author by Dr. W. Allen, of Massachusetts, with the largest accumulation of this substance he has ever seen in one mass. Its longest diameter is an inch and an eighth, its shortest seven-eighths, and its thickness five-eighths of an inch. Imbedded in its substance is the entire crown and neck of a lower dens sapientiæ, which was removed with it. It is of a light brown color, and weighs two drachms and seventeen grains.

Professor Austen describes a remarkable case where every tooth above and below had been loosened by alveolar absorption caused by this deposit; no tooth having more than an eighth of an inch depth of socket, and some of them held only by an exceedingly tough attachment to the gum and periosteum. The tartar upon the lower incisors was equal to five times the size of the teeth; most of it being on the inside and three-quarters of an inch thick at the base. A singular peculiarity in this case was the excessive pain of extraction. Small as was the attachment, it was uncommonly firm; and the patient, a working man, was laid up with nervous prostration for two weeks after the operation.

CHEMICAL CONSTITUENTS OF SALIVARY CALCULUS.

Salivary calculus is composed of phosphate of lime and animal matter, combined in various proportions, accordingly as it is hard or soft; consequently no two analyses will yield the same result. The following is the analysis made by Mr. Peps for Mr. Fox. Fifty parts yielded:

Phosphate of lime,	35
Fibrin, or cartilage,	9
Animal fat, or oil,	3
Loss,	3
	50

Berzelius gives the following analysis. He found one hundred parts to contain

Phosphate of lime and magnesia,	79.0
Salivary mucus and salivine,	13.5
Animal matter,	7.5
	100.0

Dr. Dwinelle, of New York, furnishes the following:

Phosphate of lime,	60
Carbonate of lime,	14
Animal matter and mucus,	16
Water and loss,	10
	100

The last named gentleman acknowledges that he could make no two analyses agree. Hard dry tartar contains more earthy and less animal matter than the soft humid tartar.

The infusoria of which M. Mandl says tartar is composed, have their origin in the vitiated mucus which is always mixed with it. Scherer detected with a microscope in large numbers, infusoria, in the saliva of a girl laboring under a scorbutic affection of the mouth; but the author is inclined to believe that they had their origin in the mucous secretions of this cavity, which are always mixed with the former fluid. They are more or less numerous, as the tartar is hard or soft, or in proportion to the quantity of mucus that enters into its composition.*

ORIGIN AND DEPOSITION OF SALIVARY CALCULUS.

There exists much diversity of opinion as to the source from whence salivary calculus is derived. English and American writers believe it to be a deposit from the saliva, but the French do not agree concerning its origin. Jourdain thinks it is secreted by glands, which he believes to be scattered over the periosteum of the teeth. Gariot says it comes from the gums. Serres tells us he has discovered upon the mucous membrane of the gums, certain glands, whose particular function it is to secrete this substance. In commenting upon the views of this last mentioned author, M. Delabarre remarks: "The small *dental* glands," as he calls them, "perhaps belong to the mucous or salivary system; for the saliva, as all physiologists know, is not furnished by the parotid and other larger glands alone, but by a great number of small glands that are very observable in ruminating animals, scattered over various parts of the mucous membrane of the mouth. I, therefore, am of opinion that this is a gratuitous supposition on the part of the author; because children of a very early age are not affected with tartar, and it is on them that he believes he has discovered the glands which produce it. Did these really exist, they would augment instead of decreasing in size, as age advanced; and their functions becoming more and more established, they would attain to a very large size in old persons and those

* Dr. Dwinelle gives a minute description of their appearance in the 1st No. of the 5th volume of the American Journal of Dental Science.

most subject to tartar. Now, there is nothing to lead one to infer their existence in these individuals. Therefore, to suppose that organs, which may be very perceptible before their function begins, cannot be discovered when their secretion is fully established, is contrary to sound philosophy; in this case, the *dental glands* of the author would be entirely different from all others, which are the more distinct in proportion as they are more active. Inadmissible, then, as this supposition is, I do not believe in the existence of these glands, which I have patiently but in vain searched for."

Mons. Serres referred probably to the small glands lying under the mucous membrane, which have no more special action in the deposition of calculus than any other of the salivary glands. The largest are about the size of a small pea, and have been termed, according to their situation, the *labial*, *buccal* and *molar* glands.

But M. Delabarre is not more fortunate in the theory which he advances of the origin of salivary calculus, than Serres. He believes it to be an exhalation from the mucous membrane of the gums. Alluding to what M. Dupuy, professor of the veterinary establishment at Alfont, says, concerning the formation of calcareous tubercle in soft tissues, where he supposes there are no other fluids but mucus; he tells us that it is "in the same manner that the exhalants of the gums furnish tartar, which they give out more or less accordingly as the gums are in a healthy or inflamed state. When diseased, they are covered with a whitish layer, which is at first soft, but gradually collecting upon the teeth, it afterward becomes hard." According to this author, it is only when the gums are inflamed that tartar is produced.

In this way he accounts for its accumulation on the teeth of one side of the mouth, while those of the other have none of it on them, though they are all alike bathed in the saliva. The concretion of earthy salts in the salivary ducts, he accounts for by supposing it to be deposited by the exhalants of the mucous membrane which lines them, and not from the fluid they convey to the mouth.

He accounts for analogous formations in other parts, in the same way. The calculous incrustation upon a sound, which has

remained in the bladder for a long time, and which is found in cases where no previous disposition to gravel had existed, he supposes to result from irritation excited by the instrument in the mucous membrane of this viscus. In replying to this part of his argument, Mr. Bell says: "The previous non-existence of calculus in the bladder cannot be deemed any proof that the elements of its composition had not been held in solution in the urine; requiring only the occurrence of any extraneous body in the bladder to serve as a nucleus for its deposition. This view of the subject is amply confirmed by the fact, that depositions, both of the lithic salts and of the triple phosphate, the bases of the usual varieties of urinary calculi, are constantly formed from the urine, after its expulsion from the bladder."

It is unfortunate for M. Delabarre that he drew this analogy, for Mr. Bell has shown it to be conclusive against the theory which he intended to establish by it. He says; "that salivary calculus, or tartar of the mouth, is deposited in a similar manner from the saliva, is, I think, directly proved; or is at least supported in the highest degree of probability by every circumstance connected with its formation." The fact, too, that it is always found in largest quantity on the teeth opposite the mouths of the salivary ducts, is of itself a strong argument in favor of this theory; but still more conclusive is the fact of its formation within the very ducts themselves.

The theory of M. Delabarre is insufficient for the explanation of its deposition here; for it is not presumable that inflammation would seize upon a single point of the mucous membrane of one of these passages, without affecting it to a considerable extent. The most probable cause of its formation here, as it appears to us, is the accidental precipitation of a particle of it from the saliva in its passage to the mouth; which particle, becoming entangled in the mucus, is detained, and afterwards serves as a nucleus for subsequent deposition.

Of the existence of the elements of the composition of calculus in the saliva there can be no question. Chemical analyses of this fluid, direct from the glands, place all doubt upon the subject at rest. Turner, in enumerating the chemical constituents of saliva, mentions bone earth as one;* and Tiedemann,

* Turner's Chemistry, p. 756.

Gmelin,* and Scherer,† have detected phosphate of lime; as has also Enderlin,‡ and other chemists who have analyzed this fluid. Thus it is seen that the chief earthy constituents which enter into the formation of this substance are contained in the saliva. It may also exist in solution in the mucous fluid of the mouth.

M. Delabarre seems to rely upon the circumstance, that its deposition on the teeth is always accompanied by inflammation of the gums, as conclusive in favor of the correctness of his views of its formation. But here, again, he is equally unfortunate; for the inflammation of which he speaks is the effect, and not, as he supposes, the cause, of its deposition. The soft, white layer of tartar, of which he makes mention, as observable on the gums when diseased, is nothing more than thick, hardened mucus. We have repeatedly examined it, and are well assured of the correctness of this assertion.

That the deposition of tartar may take place on one side of the mouth, without a similar deposit on the opposite side, furnishes no evidence in support of the doctrine that it is an exhalation from the capillaries of the mucous membrane of the gums. The mastication of food is, with most persons, performed more on one side of the mouth than on the other; that this function prevents, in a great degree, the accumulation of tartar on the organs immediately concerned, is a fact with which every dentist must be familiar. Hence, its frequent collection on the teeth of one side, and not on those of the other. And that it is ascribable to this circumstance, is susceptible of positive proof. If, on the removal of the tartar from the teeth of a person, in whose mouth it has collected only on those of one side, mastication be afterwards altogether performed on this side, it will not re-accumulate on them; and if requisite attention to the cleanliness of the teeth on the other side be not observed, it will soon collect there, although these teeth had before remained free from it.

Again, it often happens that disease of a severe character is excited in the gums by the use of mercurial medicines and other causes, and yet but a small quantity of tartar collects on the

* Müller's Physiology, vol. i, p. 461. † French Lancet, April, 1845.

‡ Liebig, Annalen, 1844, pp. 3 and 4.

teeth; but that any condition of the general system, or of the mouth, tending to make the fluids of this cavity more viscid, promotes its formation, is undeniable. There are, however, some temperaments much more favorable to its production than others; and it is a well-established fact, that the mucous membrane of those in whose mouths it accumulates in largest quantity is the most irritable, and the buccal fluids most viscid. Again, if it were deposited by the mucous fluids of the mouth, it would collect in largest quantities on those teeth which are less abundantly bathed in the saliva; as, for example, the anterior surfaces of the upper incisors and cuspids, while those opposite to the mouths of the ducts, which discharge this fluid into the mouth, would be less liable to deposits of tartar than any of the other teeth; whereas the contrary is found to be the case.

From all the light, therefore, that has been thrown upon this subject, the conclusion appears to us irresistible, that this earthy matter is chiefly a salivary deposit, and takes place in the following manner: It is precipitated from the saliva, as this fluid enters the mouth, upon the surfaces of the teeth, opposite the openings into the ducts, from which it is poured. To these its particles become agglutinated by the mucus always found, in greater or less quantity, upon them. Particle after particle is deposited, until it sometimes accumulates in such quantities that nearly all the teeth are almost entirely encrusted with it. It is always, however, found in greatest abundance on the outer surfaces of the superior molars and the inner surfaces of the inferior incisors, and it is opposite to these that the mouths of the salivary ducts open.

EFFECTS OF SALIVARY CALCULUS UPON THE TEETH, GUMS AND ALVEOLAR PROCESSES.

The effects of the presence of this substance on the teeth are always pernicious, though sometimes more so than at others. An altered condition of the fluids of the mouth, diseased gums, and not unfrequently the gradual destruction of the alveolar processes, and the loosening and loss of the teeth, are among the consequences that result from it. But beside these, other effects are occasionally produced, among which may be enume-

rated: tumors and spongy excrescences of the gums, of various kinds; necrosis and exfoliation of the alveolar processes, and of portions of the maxillary bones; hemorrhage of the gums; anorexia, derangement of the whole digestive apparatus and foul breath; catarrh, cough, diarrhœa; diseases of various kinds in the maxillary antra and nose; pain in the ear, head-ache; melancholy, hypochondriasis, &c. The character of the effects, however, both local and constitutional, depends upon the quantity and consistence of the tartar, and upon the temperament of the individual as well as the state of the general health; the two former of these are determined by the two latter, and by the attention paid to the cleanliness of the teeth. If this last be properly attended to, salivary calculus, no matter how great the constitutional tendency to its formation, will not collect in large quantity upon the teeth. The importance, therefore, of its constant observance cannot be too strongly impressed upon the patient, especially upon those in whom there exists a great tendency to its deposition.

The teeth and their contiguous parts suffer more from accumulations of this substance, than almost any other cause. Caries is not much more destructive to them. When permitted to accumulate for any great length of time, the gums become so morbidly sensitive, that a tooth-brush cannot be used without causing pain: consequently, the cleanliness of the mouth is not attempted, and thus, no means being taken to prevent its formation, it accumulates with increased rapidity, until the teeth, one after another, fall in quick succession victims to its desolating ravages.

It sometimes not only undermines the constitution, by occasioning discharges of fetid matter from the gums, and corrupting the fluids of the mouth; but it also renders the breath exceedingly unpleasant and offensive. So nauseating and disagreeable is the odor which some descriptions of tartar exhale, that the atmosphere of a whole room is contaminated by it in a few minutes.

MANNER OF REMOVING SALIVARY CALCULUS.

This is an operation of great importance to the health of the gums, alveolar processes and teeth. But from a misconception of its nature, rather than from fear of pain, many are much opposed to it: and notwithstanding the universal admiration in which clean and white teeth are held, they will suffer the beauty of these organs to be destroyed, rather than submit to its performance. There are some, indeed, who though scrupulously particular in everything that regards dress, seem, nevertheless, to consider cleanliness of the mouth as unworthy of notice.

For the removal of tartar from the teeth, a variety of instruments are necessary, which should be so constructed, that they may be easily applied to every part of every tooth. Those in common use among dental practitioners are so very similar in in their shape, and so well known, that we do not deem it necessary to point out the minute differences of construction, or even to give a general description of the instruments themselves. The instruments should be light, made with ivory, ebony or cocoa handles, and tapering from a little above the ferule, both ways; and the points of the instruments should be delicately shaped so as readily to pass below the free edge of the gum. The success of the operation depends much upon the careful removal of every particle of deposit; for which a heavy, clumsy or large bladed instrument is wholly unsuited. If any particles of tartar be suffered to remain, they will irritate the gums, and serve as nuclei for immediate re-accumulations.

The adhesion of tartar to the teeth is sometimes so great, that considerable force is required for its removal, even when the sharpest and best tempered instruments are employed: but ordinarily it may be removed with ease. Considerable tact, however, is necessary to perform the operation in a skillful manner; more than most persons, from its apparent simplicity, imagine. This skill can only be acquired by practice. Tartar may be taken from the outer and inner surfaces of the teeth without much difficulty; but the removal of it from between them, is more troublesome, and can only be effected by means of very thin, sharp pointed instruments.

Several sittings are sometimes necessary for the completion of the operation, especially when the tartar has accumulated in very large quantities. In all cases of this sort, it should be first removed from between the edges of the gums, and the necks of the teeth. During the intervals between the several operations, the mouth should be gargled several times a day, with some cooling and astringent wash; but on this subject more particular directions will be given in the next chapter.

During the removal of tartar from the teeth, the gums often bleed very freely; and when much swollen and spongy, it may be well to promote it by holding tepid water in the mouth. When the lower incisors are loose, as is often the case, the operation should be proceeded with very cautiously, especially when the tartar is very hard and adheres with great tenacity.

Chemical agents are sometimes employed for the removal of salivary calculus, especially such of the mineral acids as are supposed to have less affinity for the lime of the teeth than the phosphoric with which it is combined; but it is scarcely necessary to say, that any acid capable of dissolving tartar will act upon these organs. The use of all such agents should be most scrupulously avoided. Nearly all acids, both mineral and vegetable, as has been shown in a preceding part of this work, are prejudicial to the teeth. Their careless administration by physicians is a fruitful source of injury to the teeth. And they certainly should form no part of any dentrifice, or be in any way used for the removal of stains of any kind from the teeth.

CHAPTER SECOND.

DISEASES OF THE GUMS.

The gums and alveolar processes, from apparently the same cause, frequently assume various morbid conditions. An unhealthy action in one is almost certain to be followed by disease in the other. The most common form of disease to which these parts are subject is usually, though very improperly, denominated scurvy, from its supposed resemblance to *scorbutus*, a disease belonging to the Class CACHEXIÆ, and Order *Impetiginis*, of Cullen; to which, however, it bears no resemblance. Instead, therefore, of continuing the use of this term, we propose to treat the disease under the name of *chronic inflammation and tumefaction of the gums, attended by recession of their margins from the necks of the teeth*, which seems to express more clearly the condition of the parts and the nature of the disease. The gums sometimes, though less frequently, become the seat of acute inflammation. The other affections to which they are liable will be noticed in their appropriate place.

The diseases of the gums and alveolar processes are divided by Mr. Bell into two classes: those which are the result of local irritation, and those which arise from constitutional causes.

Were it not for local irritation in these parts, the constitutional tendencies to disease would rarely manifest themselves; and, on the other hand, were it not for constitutional tendencies, the effects of local irritation would seldom be of a serious character. "Thus," says Mr. Bell, "the same cause of irritation which, in a healthy person, would occasion a simple abscess, might, in a different constitution, result in ulceration of a decidedly cancerous type; or in the production of fungous tumors, or the formation of scrofulous abscesses."

Each constitution has its peculiar tendency; or in other words, is more favorable to the development of some forms of disease, than others; and this tendency is always increased or diminished,

according to the healthy or unhealthy performance of the functional operations of the body generally. Thus, derangement of the digestive organs increases the tendency, in an individual of a mucous habit, to certain forms of diseased action in particular organs, and especially in the gums. A local irritant, which would otherwise produce only a slight inflammation of the margins of the gums, would now give rise to turgidity and sponginess of their whole structure. The same may be said with regard to a person of a scrofulous or scorbutic habit.

The susceptibility of the gums to the action of morbid irritants, is always increased by enfeeblement of the vital powers of the body. Hence, persons laboring under excessive grief, melancholy, or any other affection of the mind; or under constitutional disease, tending to enervate the vital energies of the system; are exceedingly subject to inflammation, sponginess and ulceration of the gums. But, notwithstanding the increase of susceptibility which the gums derive from certain constitutional causes and states of the general health; these influences may, in the majority of cases, be counteracted by a strict observance of the rules of dental hygiene; or, in other words, by constant and regular attention to the cleanliness of the teeth.

A local disease, situated in a remote part, often has the effect of diminishing the tendency in the gums to disease; but when, from its violence or long continuance, the general health becomes implicated, the susceptibility of these parts is augmented.

Although deriving their predisposition to disease from a specific, morbid constitutional tendency, they, nevertheless, when diseased, contribute in no small degree to derange the whole organism. Their unhealthy action vitiates the fluids of the mouth, and renders them unfit for the purposes for which they are designed; hence, when these parts are restored to health, whether from the loss of diseased teeth, or the treatment to which they may have been subjected, the condition of the general health is always immediately improved.

Thus, while the susceptibility of the gums to morbid impressions is influenced by the state of the general health, the latter is equally influenced by the condition of the former. And, not only is a healthy condition of the gums essential to the general health, but it is also essential to the health of the teeth and

alveolar processes. From the intimate relation that subsists between the former and latter, disease cannot exist in one, without in some degree affecting the other. Caries of the teeth, for example, often gives rise to inflammation of the gums and alveolo-dental periosteum; on the other hand, inflammation of these parts vitiates the fluids of the mouth, and causes them to exert a deleterious action upon the teeth, and also excites more or less constitutional derangement.

ACUTE INFLAMMATION OF THE GUMS.

Acute inflammation of the gums frequently occurs in connection with stomatitis, or general inflammation of the mucous membrane of the buccal cavity, which appears under a great variety of forms. In this case the inflammatory action does not always extend to the subjacent fibro-cartilaginous structure; but the local disease is often complicated with other disorders, the treatment of which comes more properly within the province of the medical than that of the dental practitioner. Ulitis, or acute inflammation of the gums, is in most cases, a purely local disease, arising usually from the irritation of dentition, or as a consequence of periodontitis. It often extends to the submaxillary glands and muscles of the face, and is attended by swelling and other morbid phenomena. But as this form of inflammation of the gums is treated of in connection with other subjects, it will not be necessary to repeat what we have said elsewhere concerning it.

CHRONIC INFLAMMATION AND TUMEFACTION OF THE GUMS ATTENDED BY RECESSION OF THEIR MARGINS FROM THE TEETH.

The affection which we are now about to consider has been variously designated. Jourdain and other French writers term it, in its more advanced stages, *conjoined suppuration;* because it is then complicated with a discharge of purulent matter from between the edges of the gums and the necks of the teeth, and with a gradual destruction of the alveolar processes. Dr. Koecker calls it the *devastating process*, because it is attended by wasting of the gums and alveoli. But it is more frequently

treated of under the appellation of *scurvy* than under any other name.

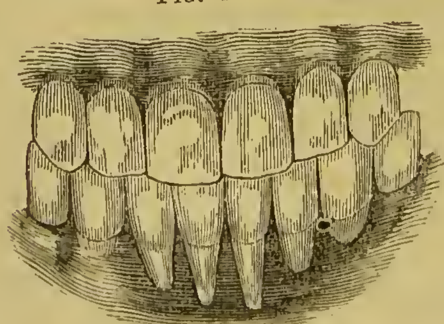
Chronic inflammation of the gums may exist for years without being attended with suppuration, or recession of their margins from the necks of the teeth; but these phenomena are sooner or later developed according to the amount of local irritation and the state of the constitutional health and habit of body. With the occurrence of inflammation the margins of the gums gradually lose their festooned appearance; become thick, spongy and rounded; and ultimately, on being pressed, purulent matter is discharged from between them and the necks of the teeth. Their sensibility is increased, and they bleed from the most trifling injury.

The diseased action usually first develops itself in the gums around the lower front teeth and the upper molars, opposite the mouths of the salivary ducts; also in the immediate vicinity of aching, decayed, dead, loose, or irregularly arranged teeth, or in the neighborhood of roots of teeth; from thence it extends to the other teeth. The rapidity of its progress depends on the age, state of the general health, temperament and habit of body of the individual, and the character of the local irritants which have given rise to it. It is always more rapid in persons addicted to the free use of spirituous liquors, and in individuals in whom there exists a scorbutic tendency; or who have suffered from venereal disease, or from the constitutional effects of a mercurial treatment used to cure this or other diseases.

The inflammation may be confined to the gums of two or three teeth, or it may extend to the gums of all the teeth, in one or both jaws.

As the disease advances, the gums begin to recede from the necks of the teeth, and the alveoli to waste, and the teeth, as they lose their support, loosen and ultimately drop out. In Fig. 160 is represented a case in which nearly one-half of the roots of the lower incisors have become exposed by this devastating process.

Fig. 160.



But the loss of the teeth, though it puts a stop to the local disease, is not the only bad effect that results from it. Constitutional symptoms often supervene, more vital organs become implicated, and the health of the general system is sometimes very seriously impaired. Hence, the improvement often observed after the loss of the teeth, in the general health of persons whose mouths have for a long time been affected with this disease. No condition of the mouth has a greater tendency to deteriorate its secretions, and impair the functions of mastication and digestion than the one now under consideration.

In forming an opinion of the injury likely to result from the disease, the dentist should be governed not only by the health and age of the patient, and the local causes concerned in its production; but he should also endeavor to ascertain whether it is connected with a constitutional tendency, or is purely a local affection. Some have been led to believe, that the wasting of the gums and alveolar processes may sometimes take place without being connected with any special local, or constitutional cause; that it is identical with that process by which the teeth of aged persons are removed, and that when it occurs in persons not past the meridian of life, it is symptomatic of a kind of premature old age.

Mr. Bell, on this subject, remarks: "In forming a judgment upon cases of this description, however, and even upon those in which the loss of substance is associated with more or less of diseased action, it is necessary to recollect that the teeth are generally removed in old age by this identical mode; namely, the destruction of their support, by the absorption of the gums and alveolar processes; and as this step toward general decay commences at very different periods in different constitutions, it may, doubtless, in many cases, even in persons not past the middle period of life, be considered as an indication of a sort of premature old age, or an anticipation, at least, of senile decay, as far as regards these parts of the body."

The loss of the teeth, from the wasting of the gums and alveolar processes, although occurring frequently in advanced life, is not a necessary consequence of senility, for we occasionally see persons of seventy, and even eighty years of age, whose teeth are as firmly fixed in their sockets and their gums as little

impaired, as in individuals at twenty. We do not recollect ever to have seen a case of this kind in which there was not evidently some diseased action in the gums. But it is of little importance whether it be the result of old age, a constitutional tendency, functional derangement of some other part, or local irritation, since the consequences resulting from such loss are always the same.

The gums after having been once the seat of chronic inflammation, are ever after more susceptible to the action of morbid irritants.

CAUSES.

The immediate or exciting cause of inflammation of the gums, is local irritation, produced—by salivary calculus; by carious, dead, loose or aching teeth, or roots of teeth; or by teeth which occupy a wrong position, or that are crowded in their arrangement. It may also be produced by very hard teeth, which, in consequence of their density, possess only a very low degree of vitality; for cases of recession of the gums, in which a very slight inflammatory action exists, are frequently met with in individuals having teeth of this description. This can only be explained, by supposing a want of congeniality between these organs and the more sensitive and highly vitalized parts with which they are in immediate contact. The same thing is observed when the vitality of the teeth is weakened by age, which Mr. Bell regards as an indication of senile decay.

The secretions of the mouth, especially the mucus, are often rendered, by certain conditions of the general system, so acrid as to become a source of irritation to the gums.

Dr. Koecker, who has had the most ample opportunities of observing this affection in all its various forms, says that he has never seen a case in which tartar was not present. That this is so in a large majority of the cases, there is no question; but that it is in all, is certainly a mistake. The author has met with many in which not the smallest deposit could be detected.

The disease attacks persons of every age, rank, and condition; and in every country, climate, and nation. "I have observed," says Dr. Koecker, "the inhabitants of the most widely separated countries, Russians, French, Italians, Spaniards,

Portuguese, English, Africans, East and West Indians, and those of the United States, to be all more or less liable to it."

It is, however, more frequently met with in the lower than in the higher classes of society. Persons who pay no attention to the cleanliness and health of their teeth are particularly subject to it. With sailors, and those who live principally on salt provisions, it is very common. "Persons of robust constitution," says Dr. Koecker, "are much more liable to this affection of the gums than those of delicate habit; and it shows itself in its worst form after the age of thirty, oftener than at any earlier period."

To the causes of irritation, which have already been enumerated, may be added—accumulation of extraneous matter on the teeth and along the edges of the gums; exodontosis; artificial teeth badly inserted, or made of improper material; and dental operations badly performed. The use of improper tooth-brushes and powders, especially charcoal, may be reckoned among its exciting causes. The irritability of the gums is sometimes increased by the use of acids; at other times it is diminished.

Every condition of the general system, tending to increase the susceptibility of the gums to the action of local irritants, favors the production of the disease. Every thing that tends to induce such conditions may be regarded as a predisposing cause; such as, bilious and inflammatory fevers, the excessive use of mercurial medicines, the venereal virus, intemperance and debauchery. Any deterioration of the fluids of the body is peculiarly conducive to it. Persons of cachectic habit are far more subject to it, and generally in its worst forms, than those individuals in the enjoyment of good health.

Strumous individuals sometimes have an affection of the gums, which differs in many respects from the one just described. The gums, instead of being purple and swollen, are pale and harder than ordinary; and, on being pressed, discharge muco-purulent matter, of a dingy white color. They often remain in this condition for years, without appearing to undergo any structural alteration, or to affect the alveolar processes. This form of the disease is principally confined to persons who have very white teeth; it is much less likely to attack males than females; and has never, so far as we have been able to ascertain, been men-

tioned by any dental writer. Mr. Fox speaks of ulceration of the gums in scrofulous children; but that is of frequent occurrence, and is characterized by the usual phenomena of inflammation. This disease now spoken of rarely occurs before the age of eighteen or twenty; and it seems to be the result of impaired nutrition. The gums exhibit no sign of inflammatory action; on the contrary, they are paler, less sensitive, and possess less warmth than usual. It is never attended with tumefaction or absorption, except in its advanced stages; whereas, the affection of which Mr. Fox speaks is always accompanied by both.

TREATMENT.

In the treatment of inflamed, spongy and ulcerated gums, the first thing claiming attention, is the removal of the exciting causes. If there are dead or loose teeth in the mouth, or teeth which, from their position, act as mechanical irritants, they should be at once extracted. The remaining teeth should, at the same time, be freed from tartar and all other irritating depositions.

Dr. Koecker goes so far as to recommend the extraction of any molar tooth, particularly in the upper jaw, which has lost its antagonist; believing that a tooth under such circumstances is a source of irritation to the alveolo-dental periosteum and gums. He says, "In this manner the loss of one molar tooth produces the destruction of its remaining antagonist. This is effected, however, after a struggle of nature, of very long duration, which always involves, in some degree, all the other teeth in a like diseased condition; it is necessary, therefore, to prevent this morbid condition, particularly pernicious in this disease, by the extraction of the tooth, or any molar so situated."

Although a molar tooth, after having lost its antagonist, is sometimes a source of irritation, it may often remain with impunity. Its removal is necessary only when it acts as an irritant to the gums; and it may, in a majority of cases, be prevented from doing this by keeping it constantly clean.

It is essential, in the treatment of the disease under consideration, that a decided impression be made upon it at once; consequently, no time should be lost in the removal of local exciting causes. "The advantage derived from this operation," (extrac-

tion of dead, loose, or irritating teeth,) says Dr. Koecker, "would be either partly or wholly lost, were it performed at different periods." This observation has been verified by the author more than once. When he has been prevented by the timidity of his patient from extracting all the offending teeth, at the first sitting, he has always found the cure much retarded, and, in some instances, almost entirely defeated.

Having extracted such teeth as it may be necessary to remove, Dr. Koecker thinks it better to wait ten or fifteen days before the tartar is removed. The author has never been able to discover any advantage in such delay; on the contrary, he regards it as important that as much as possible should be taken from the teeth at the time of the extraction. Several sittings, however, are often required for its complete removal.

The bleeding from the gums and sockets, occasioned by these several operations, should be promoted by frequently washing the mouth with warm water; and when the gums are much swollen, advantage will be derived from scarifying them freely every three or four days with a sharp lancet. This last operation is highly recommended by Hunter, Fox and Bell, and indeed its good effects are so apparent that it should never be neglected.

The cure may be hastened by washing the mouth several times a day with some tonic and astringent lotion. The author has found the following to be very serviceable:

℞: Powdered nut galls,		
" Peruvian bark,	each, 2	drachms.
" orris root,	1	drachm.
Infusion of roses,	4	fluid ounces.

The infusion to stand for a day or so upon the powders, with frequent stirring; then decant and filter.

Mr. Fox says great benefit is derived from the use of sea water, and he recommends it whenever it can be procured; adding, that if the gums be tender, it should be used warm. We are unable to speak of the merits of this remedy from experience, never having tried it. We have, in cases where there was much soreness and ulceration of the gums, prescribed the following:

℞:	Borax,	2 scruples.
	Honey,	1 fluid ounce.
	Sage tea,	4 " ounces.

This is a favorite and very general domestic remedy, and will be found very soothing and healing.

As a wash for the mouth, Dr. Fitch recommends a decoction of the green inner bark of white oak, which we have found beneficial. The following are recommended by Dr. Koecker, as being very serviceable:

"Take of clarified honey, three ounces, and of vinegar, one ounce. This, diluted in the proportion of three tablespoonfuls to a pint of warm sage tea, or water, may be used frequently during the day.

"Take of clarified honey, and of the tincture of bark, two ounces each. Mix and dilute as above.

"Take of honey, and of the tincture of myrrh, two ounces each. Mix and use as above."

Mr. Bell recommends the following;

℞:	Alum,	2 drachms.
	Decoction of Peruvian bark,	2 fluid ounces.
	Infusion of roses,	2 " "

But when the last prescription is used, the mouth, immediately after, should be thoroughly washed with water and a soft brush, to prevent the sulphuric acid of the alum from exercising a hurtful effect upon the teeth.

The pleasantest, and at the same time the most efficacious, mouth-wash which the author has ever employed is the following:

℞:	South American soap bark,	8 ounces.
	Pyrethrum, Orris root, Benzoic acid, Cinnamon, each,	1 ounce.
	Tannic acid,	4 drachms.
	Borax,	4 scruples.
	Oil of wintergreen,	2 fluid drachms.
	Oil of peppermint,	4 fluid drachms.
	Cochineal,	3 drachms.
	White sugar,	1 pound.
	Alcohol,	3 pints.
	Pure water,	5 pints.

Mix the ingredients thoroughly, digest for six days and filter.

If, notwithstanding the use of the means here recommended, matter still be discharged from around the necks of the teeth, and should the gums continue spongy, and manifest no disposition to heal, their edges may be touched with a strong solution of the nitrate of silver. This will seldom fail to impart to them a healthy action. It may be used in the proportion of from three to twelve grains to one ounce of water. The most convenient mode of applying it is with a camel's-hair pencil. Its use is recommended by Mr. Fox, and will often succeed when other remedies fail. In those cases where the matter discharged from the edge of the gum has a nauseating and disagreeable odor, "a weak solution," says he, "is an excellent remedy for rendering the mouth sweet and comfortable;" but in using it in this way, precaution is necessary to prevent it from getting into the fauces, as, in this case, it will cause disagreeable nausea. An excellent disinfectant, in such cases, is a gargle made by diluting a teaspoonful of chlorinated soda (Labarraque's solution) in four or eight ounces of water. Or it may be used much stronger and applied with a small mop to the diseased parts; the silver nitrate may be applied in the same way.

While the means here directed for the cure of the disease are being employed, a recurrence of its exciting causes must be studiously guarded against. Tartar and foreign matter of every kind should be prevented from accumulating on the teeth, by a free and frequent use of a suitable brush and waxed floss-silk; until a healthy action be imparted to the gums, these should be used at least five times a day: immediately after rising in the morning, after each meal, and before retiring at night. The application of the brush may at first occasion some pain; but its use should, nevertheless, be persisted in, for, without it, all the other remedies will be of little avail. The friction produced by it, besides keeping the teeth clean, is of great service to the gums, in imparting to them a healthy action.

Treatment, different from that here described, is necessary in that form of disease which we noticed as being characterized by preternatural paleness and discharge of muco-purulent matter from between the edge of the gum and the neck of the tooth. In the first case of this disease treated by the author, he directed astringent and detergent lotions to be used; but these did not

produce the desired effect. Having been led from his observation in this case to suspect that the disease was connected with some constitutional derangement, and was probably the result of a debilitated condition of the general system, he recommended, in the next case, the use of tonics and free exercise in the open air. This course, though attended with evident improvement of the general health, seemed to be productive of no benefit to the gums. They still appeared debilitated, and on being pressed, discharged matter from beneath their edges. He advised a continuance of the tonics and exercise, and with a view of exciting inflammation, touched the edges of the gums with nitrate of silver. This had the desired effect, and, as he had anticipated, a new disease was substituted for the old one; for the cure of which, he directed the mouth to be washed, five or six times a day, with the mixture of sage tea, alum and honey, and at night and morning with salt water.

This treatment was perfectly successful. In about three weeks the gums assumed a healthy appearance, acquired their natural color, and the discharge of muco-purulent matter entirely ceased. He has since had occasion to treat several other cases, in all of which he adopted the same treatment, and with like success.

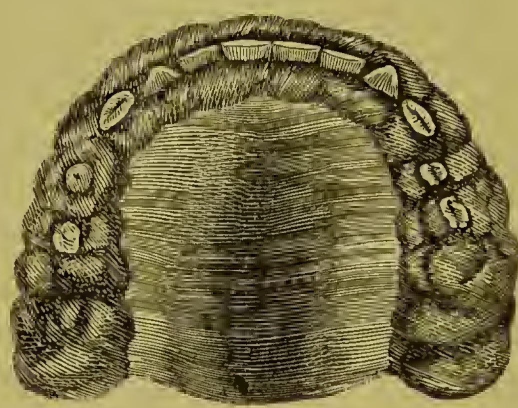
MORBID GROWTH OF THE GUMS.

The structural changes which take place in the gums, as a consequence of increased vascular action, are almost as various as are the constitutional tendencies of different individuals. Those characterizing the affection last noticed, consist, for the most part, in increased thickness and recession of their edges from the necks of the teeth; but in the one of which we are now about to treat, there is morbid growth which is sometimes so considerable, that it almost covers the crowns of the teeth, thus interfering very seriously with the function of mastication. When thus affected, the gums have a dark purple color, with thick, smooth and rounded margins; and discharge almost constantly from their inner surface, a thin, purulent matter, which exhales an exceedingly offensive odor. They bleed profusely from the slightest injury, and are so sensitive that the pressure even of the lips is sometimes attended with pain. They are also

affected with a peculiar itching sensation, which, at times, is a source of great annoyance.

The accompanying engraving (Fig. 161) will convey to the reader a more correct idea of the appearance of the gums, when thus affected, than any description which can be given. It will be perceived from this, that the morbid growth extends to the gums of all the teeth, as it usually does in this variety of diseased action.

Fig. 161.



Among the local and constitutional effects arising from the disease are—offensive breath; vitiated saliva; destruction of the alveoli, with loosening and ultimate loss of the teeth; impaired digestion, with all its disagreeable concomitants; enlargement of the tonsils and bronchitis, together with a long train of other morbid phenomena.

CAUSES.

The exciting cause of this peculiar affection is local irritation, produced by salivary calculus, dead, diseased or irregularly arranged teeth; but the character of the structural alteration is evidently determined by some cachectic habit of body or constitutional tendency. It often attacks the gums of individuals whose teeth are sound and well arranged, but the author has never met with a case in which tartar was not present; though, in some instances, the quantity was so small as almost to lead one to doubt whether it could have had much agency in the production of the disease. But the susceptibility of the gums to morbid impressions, in individuals liable to this affection, is usually so great, that an irritant, which under other circumstances would scarcely excite an increase of vascular action, gives rise, in cases of this sort, to the rapid development of an aggravated form of disease.

TREATMENT.

The first thing to be attended to in the treatment of the disease, is the removal of all dead teeth and such others as may in any way irritate the gums. The morbid growth should be next removed, by making a horizontal incision entirely through the diseased gums to the crowns of the teeth. This should be carried as far back as the morbid growth extends. After this, the gums should be freely scarified by passing a lancet between the teeth down to the alveoli, in order that the vessels may be completely divided, and discharge their accumulated blood. This should be repeated several times, at intervals of four or five days. Meanwhile the mouth may be washed three or four times a day with some astringent and detergent lotion, and occasionally mopped with a weak solution of nitrate of silver. The tartar should be removed as soon as the gums have sufficiently collapsed to admit of the operation.

The progress of the disease may be arrested, but a cure cannot be affected by local treatment alone. Particular attention should be paid to the regimen of the patient, and such general remedies prescribed as the peculiar nature of the case may indicate. Excess and intemperance of every kind must be avoided. In cases of an inflammatory type, the diet should be chiefly vegetable : but where there is debility, or other cachexia, animal food should be used, taking care to avoid all young meats, as veal or lamb, all gross meats such as pork, and all salt meats or shell fish. Fruits and acid beverages, such as infusions of malt and vinegar, lemon juice, spruce beer, &c., may be used with advantage.

The teeth should be kept perfectly and constantly clean. Not a particle of foreign matter should be permitted to remain between them or along the edges of the gums. A scrupulous attention to this precaution is indispensably necessary; as it constitutes one of the most important remedial indications.

MERCURIAL INFLAMMATION OF THE GUMS.

Small and repeated doses of mercury, when carried to the point of salivation, frequently give rise to the development of peculiar morbid phenomena in the gums and other parts of the mouth. The first indication of the specific action of this powerful medicinal agent upon the animal economy, consists in a slightly increased redness and tumefaction of the free edge of the gums around the necks of the inferior incisors. There is a characteristic bluish color along the edge of the gums, while the investing mucous membrane of the adherent portion, a little lower down, often assumes a white color, owing to the opacity of the epithelium. These appearances are followed by—increased secretion of saliva; a strong metallic taste; soreness of the teeth and gums; inflammation and swelling of the mucous membrane of the roof of the mouth, fauces and cheeks, and the salivary glands; swelling of the tongue, with increased redness of its edges, and a peculiarly offensive odor of breath. In the meantime, the edges of the gums about the necks of the teeth swell and assume an increase of redness; the saliva becomes viscid and is secreted in such abundance as to flow from the mouth, and the movements of the jaws are attended with pain. The alveolo-dental periosteum is thickened, and the teeth raised from their sockets and loosened. A vesicular eruption sometimes appears, followed by ulceration and sloughing of the gums, and very frequently by necrosis of large portions of the alveolar process and maxilla. We were shown, a few years since, the entire alveolar border of both jaws, the necrosis and exfoliation of which had been occasioned by severe mercurial salivation, and we have frequently had occasion to remove portions both of the superior and inferior maxillary bones—the necrosis having been occasioned by the use of this medicine.

By the prudent administration of mercury, salivation may be induced, without causing the deplorable effects just described. But the specific action of this agent upon the constitution is always attended by more or less tumefaction and sponginess of the gums, and when once brought under its influence, however perfectly its effects may have subsided, they are ever after more

susceptible to morbid impressions. Again it should be remembered that very many of these deplorable symptoms follow the use of mercurials, even where there is no intention to salivate. It is a powerful agent, capable of much good; but one which has been productive of untold mischief, especially upon the mouth and teeth. Doubtless life must be saved at the expense, if necessary, of the teeth. But the peculiar specific action of this medicine should forbid its constant and indiscriminate employment.

TREATMENT.

It is scarcely necessary to say, that until the use of the mercury is discontinued, it will be impossible to control or even counteract its effects upon the gums; but in mild cases these usually soon disappear after the action which it has produced on the general system has completely subsided. When the gums continue spongy, the bowels should be kept open with saline aperients, the patient restricted to a fluid farinaceous diet, and the mouth gargled several times a day with demulcent decoctions and mild astringent lotions, to which it may sometimes be advisable to add a little laudanum. Washes made from chlorinated soda or lime may be used to correct the excessive fetor of the breath.

After the action of the medicine upon the system has subsided, and the disease assumes a chronic form, the gums, as directed by Mr. Thomas Bell, should be freely scarified by passing a lancet entirely through their substance between the teeth; and this operation should be repeated as often as every few days, until they are completely restored. The use of astringent washes should at the same time be continued, and if there are any teeth which, from the loss of their vitality, or from having become very much loosened by the partial destruction of their sockets, act as irritants, they should be removed.

When the gums have ulcerated, the application of a strong solution of sulphate of zinc or nitrate of silver with a camel's-hair pencil is recommended. Chomel, an eminent French physician, has employed vapor baths with advantage, in cases of mercurial stomatitis.

ULCERATION OF THE GUMS OF CHILDREN, ATTENDED WITH EXFOLIATION OF THE ALVEOLAR PROCESSES.

The gums and alveolar processes of children are occasionally attacked by a very peculiar form of disease, which occurs more frequently during the shedding of the temporary and the eruption of the permanent teeth, than at any other period of childhood. We have never known adults to be affected with it, and to the ordinary spongy, inflamed and ulcerated gums, it does not appear to be at all analogous. It bears a much closer resemblance to *cancrum oris*, yet differs in many particulars from this disease.

Among the symptoms which characterize the affection, are itching and ulceration of the gums and their separation from the necks of the teeth and alveolar processes; there is, at first, a discharge of muco-purulent matter from between the gums and necks of the teeth, which ultimately becomes ichorous and fetid. The teeth loosen, and the alveoli lose their vitality and exfoliate. Ulcers are formed in various parts of the mouth, the gums and lips assume a deep red or purple color. In the exfoliation of the alveolar processes, the temporary, and sometimes the crowns of the permanent teeth are carried away. The constitutional symptoms are: skin, for the most part, dry; pulse small and quick; the bowels generally constipated, though sometimes there is diarrhœa; and to these symptoms may be added lassitude and a disposition to sleep.

These may be regarded as the prominent phenomena of the disease in its most aggravated form. When exfoliation of the alveolar processes takes place, the symptoms usually abate, and sometimes wholly disappear. Delabarre says, "among the great number of children that are brought to the orphan asylum, he has had frequent occasion to notice singular complications of the affection, as modified by the strength, sex, and idiosyncrasies of the different subjects." The gums and lips, in some, he describes as being of a beautiful red color; in others, the lips are rosy and the gums pale, and sometimes very much swollen. He also enumerates among the symptoms, burning pain in the mucous membrane of the cheeks, and ulceration, pain and swelling in the submaxillary glands.

In the majority of cases, the disease is confined to one jaw and to one side, though sometimes both are affected by it. The effect on the permanent teeth, in all the cases which have fallen under the notice of the author, was injurious, though Delabarre says, that in children who have reached their seventh or eighth year, the teeth are not injured, except that they may be badly arranged, in consequence of the want of a proper development of the jaw.

This author enumerates the following symptoms of a very aggravated form of this disease—inordinate appetite, burning thirst; a small spot on the cheek, or about the lips, resembling an anthrax, which rapidly increases in size, turns black, separates, discharges an ichorous fluid, and its edges roll themselves up like flesh exposed to the action of a brisk fire: the flesh separates from the face; the bones become exposed, hectic fever ensues, and in the course of fifteen or twenty days, death puts an end to the sufferings of the child. Delabarre asserts that this affection is more common among females than males, and that the bones of the jaw are so much softened that they may be easily cut with a knife.

CAUSES.

The disease seems to be the result of general debility or defective nutrition and a cachectic habit of body. It never occurs among the wealthy, but is always confined to children of the poor and destitute, and so far as the author's observations extend, to those who reside in cellars or small and confined apartments. Children of scorbutic habit seem to be the most subject to it. Delabarre, however, says he has met with it in children who appear robust, and in other respects well. He locates the seat of the disease in the organs of nutrition, and in the fluids that are conveyed to them. The disposition of body which gives rise to it, he mentions as being sometimes innate, sometimes the result of a want of proper nourishment. He does not think it arises from the specific affection of any separate organ.

From the great debility of all the organs of the body, their functions are languidly and imperfectly performed. That the disease is determined by general enfeeblement of the functions

of the body, there is, we think, little doubt; but whether it would develop itself independently of any local cause, is a question which we do not feel ourself able satisfactorily to answer. It is not at all improbable, that local irritants are the exciting cause; and we are the more inclined to this belief from the fact, that in all the cases which have fallen under our observation, the teeth were considerably decayed, and had previously given rise to pain; and in some instances they were coated with tartar. While, therefore, the character of the affection is determined by some peculiar constitutional tendency and general enfeeblement of the vital powers of the body, it is not unlikely, that local irritation is the immediate cause of its development.

TREATMENT.

As the treatment of this affection comes more immediately within the province of the medical than of the dental practitioner, we shall not dwell long upon the subject.

The local treatment should consist of acidulated and astringent gargles, and a chlorinated solution of lime or soda. The ulcerated parts may be occasionally touched with a strong solution of the nitrate of silver, and Delabarre says, he has in some cases, derived great advantage from touching them with the actual cautery. As soon as the alveolar process exfoliates, it should be removed. After this takes place, a cure is generally speedily effected under proper constitutional treatment. This last may consist of mild alteratives, a generous nutritive diet, consisting of succulent vegetables; and in the absence of fever, wholesome meats, tonics, and exercise in the open air.

The author just quoted, with a view to arouse the vitality, says he has successfully employed the *juice of cruciferous plants*,* but with them he unites opium, in order to diminish their action upon the digestive apparatus. Counter-irritants, such as blisters, he employs when necessary to remove irritation of some internal organ.

* The general properties of the *crucifera* are those of pungent stimuli. They are used for nutritive condimentary and anti-scorbutic purposes. They are cardamine, horse-radish, common scurvy-grass, black and white mustard.

ADHESION OF THE GUMS TO THE CHEEKS.

The gums and inner walls of the cheeks sometimes contract adhesions which interfere seriously with the functions of the mouth. The affection may be congenital, but in a majority of the cases it occurs subsequently to birth. The extent of the adhesion may be small, or it may occupy the gums of the entire alveolar border of one or both sides of the mouth, and of one or both jaws. Desirabode relates the case of a young man, who, in consequence of a venereal ulcer, had his upper lip united to the gums of the four incisors in such a way as to form a sort of loop above the teeth, which by the retraction of the lip were caused to project outward.*

Adhesion of the gums to the cheeks or lips, results from ulceration caused either by constitutional disease or local lesions. But that it arises more frequently as a consequence of the immoderate use of mercury than from any other cause, is a universally admitted fact. The author has met with several cases, however, in which the affection had resulted from ulceration of the gums around necrosed temporary teeth; and of the corresponding wall of the cheek, caused by excoriation of the mucous membrane, produced by the sharp points of the protruding roots. But the extent of the adhesion, in cases of this sort, is never very considerable.

The proper remedy is to separate the parts which have grown together with a sharp bistoury. This done, reunion should be prevented by keeping a pledget of cotton or lint in the wound, until the process of cicatrization is completed.

* Author's translation of Desirabode's Complete Elements of the Science and Art of the Dentist, page 227.

CHAPTER THIRD.

TUMORS AND EXCRESCENCES OF THE GUMS AND ALVEOLAR PROCESSES.

From the gums and alveolar processes, tumors and excrescences of various kinds are occasionally developed, varying in character, from a mere simple growth of the gums to morbid productions of a fungoid, cartilaginous, bony or scirrhous nature. Some are smooth, others rough, and sometimes covered with eroding ulcers; some are bulbous, with a broad base, others are attached by a mere peduncle; some are soft, others are hard; the growth of some is astonishingly rapid, that of others is so slow as to be scarcely perceptible; some are almost entirely destitute of blood-vessels, others appear to be almost wholly composed of capillaries; some are nearly destitute of sensibility, others are so exquisitely sensitive, that the slightest touch produces great pain; and hence the name, *noli me tangere* (touch me not), given to one of these diseases; some are nearly white, others have a grayish appearance; some retain the natural color of the gum, others are of a dark purple hue. Finally, some exist for years without being attended with any serious consequences; while others, in a few months, assume so aggravated a character as to threaten the life of the patient.

CAUSES.

Tumors of the gums seldom arise spontaneously. They are, in most instances, the result of local irritation, occasioned by the presence of tartar, decayed or dead teeth, or roots of teeth; but the character which they assume is determined by the state of the constitutional health or habit of body. Hence their great variety. Here, as on other parts of the body, the same causes often produce different effects. One that would give rise to the development of a simple morbid growth of the gums in a person

of good health, might, in one affected with some constitutional vice or specific morbid tendency, give rise to a tumor of a fungoid, cartilaginous, bony, or scirrhous character.

It is thought by some that morbid productions of this kind are occasionally developed, independently of any local cause; but this opinion does not seem to be well founded, and we are disposed to believe that, if all the circumstances connected with the history of each case, especially the previous condition of the teeth, could be accurately ascertained, their cause might, in most instances, be traced to irritation of the gums, or alveolar membranes, produced by some unhealthy or crowded state of these organs, or to the presence of salivary calculus.

Mr. Liston, in his Practical Surgery, remarks: "Very many of the *tumors of the jaws* are traceable to faulty growth or position of the teeth, to diseases of their bodies, or to improperly conducted operations upon them." And, in speaking of tumors of the gums, he observes: "They are caused by decay of some part of one or more teeth, of the crown, neck, fang, or they may arise from their being crowded or misplaced." A crowded arrangement of the teeth is always productive of more or less irritation to the alveolo-dental periosteum.

We do not, however, conceive it necessary to the production of tumors, that any of the causes here enumerated should exist at the time they make their appearance. The gums and alveoli having been once affected, are ever after more susceptible to morbid impressions. It is, therefore, quite probable that an unhealthy action is sometimes continued in them long after the cause that produced it ceases to exist; and that this, favored by a subsequent unhealthy action of some other part, or of the system generally, determines their development. When we consider how often, and almost constantly, the gums and alveolar periosteum are exposed to irritation, from the causes just mentioned, we must admit, that this hypothesis is supported by a high degree of probability. No one, we think, will pretend to deny that the maxillæ and gums suffer more from local irritation than any of the other parts of the body; and to this irritation, we are firmly persuaded, most of their diseases are to be ascribed.

TREATMENT.

The most common form of morbid growth met with in the mouth is that which resembles in structure the gums, except that it is usually rather more vascular. This description of tumor is always the result of dental irritation, and usually disappears soon after the removal of the cause.

In 1828, the author was consulted by a gentleman who had a considerable enlargement of the gums, which had followed an attempt to extract the first superior molar of the left side. In the operation the two buccal roots were fractured and left in their sockets. For fifteen or twenty days after the accident, he experienced considerable pain; but at the expiration of this period, it had entirely subsided. About two months after, however, it was again experienced; although the gum had grown over the roots, it was sore to the touch, and soon began to assume a bulbous form, gradually increasing in size. At the expiration of twelve months, when we saw the patient, the tumor had attained the size of a black walnut, and was attached by a broad base. As it was situated immediately over the fractured roots left in the socket, we advised the removal of the tumor previously to attempting their extraction. This he most positively refused to permit, but readily consented to the removal of the roots.

In the performance of this operation, about one-third of the base was cut away, and the remaining part of the tumor sloughed off in a few days.

Mr. Fox relates the case of a lady who had an enlargement of the gums that almost entirely filled up one side of her mouth. She first applied to Sir Astley Cooper, who sent her to Mr. Fox to have several decayed roots, at the base of the tumor, extracted, before he should attempt its extirpation. The fangs being imbedded in the gums, the excrescence was much lacerated in their removal; afterwards it became flaccid, assumed a dark color, and in a short time sloughed off. Thus a perfect cure was effected without any other operation than that of the extraction of the decayed roots.

This tumor, it would seem, partook somewhat of a fungoid

character, and excrescences of this description are usually more difficult to cure than those which consist of a mere simple growth of the gums, like the one first noticed. Although they sometimes disappear spontaneously, on the removal of the exciting cause, yet, in most cases, extirpation becomes necessary, and even this when not performed in the most perfect manner, is not always successful. After the removal of one, another has been known to spring up in its place; and thus several have sometimes appeared in quick succession.

Mr. Hunter attributes the disposition of a tissue to reproduce excrescences of this kind, to a scirrhous tendency of the parts from which they originate, but the tumor will rarely reappear, if the diseased structure be completely removed.

Mr. Fox recommends that excrescences of this sort should be extirpated by means of ligatures, with the assurance that when thus removed, a second operation is seldom necessary. Excision is often attended with profuse and obstinate hemorrhage, and, on this account, the operation recommended by him is, in most cases, preferable. The base of some tumors, however, is so broad, that a ligature cannot be applied sufficiently low to include the whole structure. In such cases we must resort to excision, and if the hemorrhage cannot be stopped by compresses or by the per-sulphate of iron, the actual cautery may be employed.

Mr. Hunter, in treating of morbid growths of soft parts, observes: "Arteries going to increased parts are themselves increased, and have not the contractile power of a sound artery: hence when wounded, they bleed more freely than those that are in a healthy state."

The removal of excrescences of the gums by means of ligatures, not being attended with so much hemorrhage, and also usually exterminating them more effectually than excision, determined Mr. Fox in his choice of this mode of operating. In treating of this subject, he remarks: "I determined, some years since, that if any case of this kind should ever come under my care, I would attempt the removal by means of ligatures. The first case in which I was consulted, was a lady about forty years of age, who had several of the teeth on the right side of the upper jaw extracted when she was a young woman; about five

years before I saw her, the gums covering the jaw where the teeth had been situated, appeared to be thicker than before; they gradually increased in size until a very large tumor was formed; it had now become so large as to affect the speech, and, in other respects, was extremely troublesome.

"The lady was very desirous to have it removed; to effect which, without incurring the danger of hemorrhage, I employed ligatures, close to the jaw-bone, through the substance of the tumor, half of which was then included in each ligature. The ligatures were tied just tightly enough to stop the circulation; the next day there was a great deal of inflammation, which subsided in proportion as the ligatures began to produce ulceration, which, on the fourth day was very considerable; new ligatures were then applied; on the sixth day these were removed, and others introduced; on the eighth, one ligature came away, leaving the tumor hanging only by a small peduncle; this being cut through with a lancet, the whole was removed.

Even when the base is large, the tumor may be often successfully removed by passing a needle, armed with a double ligature, through it, close to the bone, and tying it on each side sufficiently tight to cut off the circulation between it and the general system; and it should be reapplied as often as it comes away, until the tumor has sloughed off, when the place should be touched with diluted nitrous acid or with a solution of *nitrate of silver*.

Cartilaginous excrescences of the gums and alveolar processes are comparatively of rare occurrence, and are more difficult to remove than fungous tumors, or those which consist merely of a preternatural growth of the gums. The hardness of their substance is such, that, in many cases, their removal by ligature is impracticable, and extirpation with the knife is, also, sometimes, exceedingly difficult and tedious. Besides, the operation of excision is often followed by obstinate hemorrhage.

Ambrose Paré, with no small self-gratulation, talks of having removed them when they were so large that they came out of the mouth, giving a most hideous appearance to the face, and when no other surgeon dared to undertake their cure, because of the lividity of their color. "This lividity," says he, "I did not fear, but I had the boldness to cut and even to cauterize the tumors until the disease was entirely cured."

Jourdain, in speaking of cartilaginous excrescenees, remarks: "About thirty-six years ago, I was called, with Allertius Baringue, surgeon, to see a woman that had a tumor of a large size situated on the gum of the molar teeth. It oeeasioned her mouth to be drawn to the opposite side of her face, when she was seized with spasms. We advised her not to delay too long in having it removed; to this she would not eonsent, but, in a short time, finding that the exereseenee inereased so fast, and in sueh a manner that it hindered her from taking food, she ehanged her mind. The tumor was embraeed with a brass wire, which we tightened every day. The exereseenee, reeeiving nothing now to augment its growth, fell, and, upon examination, we found that it was altogether eartilaginous."*

Dr. Fiteh quotes a ease from Luzitanus, in whieh the operation for the removal of the tumor was followed by a fatal hemorrhage. The tumor is deseribed as being about half the size of a hen's egg, exhaling a fetid odor, and being very painful. He also mentions a ease of somewhat similar eharaeter, that eame under his own observation. "The tumor oeeupied the spaee of the four ineisor teeth of the upper jaw. The teeth were all earious. I extraeted them. The tumor had four fistulous openings, one to eaeh tooth, and eaeh diseharging a fetid humor. With the aetual eautery well heated in fire and double-edged, I made but one wound of the four fistulous openings, and touehed the bone that was earious; this was repeated several times in the spaee of three months. The tumor diminished in proportion as the exfoliations were made; and the patient was eured near the end of the fourth month."†

When the base of the tumor is very broad, and the bone beneath earious, as in the ease deseribed by Dr. Fiteh, the aetual eautery is, without doubt, a sure remedy, because it is obvious that until the diseased bone exfoliates, a eure ean never be effeeted. But under no eireumstanees is the use of it advisable.

Tumors originating in the alveolar proeesses or periosteum, are generally of an osteo-sareomatous, or eartilaginous charaeter. Their removal in either ease is more diffieult than that of fungous exereseenee; and their eure less eertain.

* Jourdain, tome. 2, p. 334.

† Fiteh's Dental Surgery, p. 237.

Mr. Bell has given the history of two cases of tumors of the gums and alveolar processes. One of them, however, he says, had no connection with the alveolar processes, and the other succeeded to an attack of the tooth-ache which had lasted several months.

A case of osteo-sarcomatous tumor, occasioned by diseased teeth, is recorded by Bordenave. Sir Astley Cooper gives the history of two cases of a like nature. In one, the tumor originated in the alveolar cavities, and as it increased, displaced the teeth; in the other case the tumor was produced by diseased teeth. Dr. Gibson, also, mentions a case of osteo-sarcomatous tumor, which, "according to the patient's account, first appeared seven months before, in the form of a small lump, seated in the gum above the canine tooth."

In the treatment of tumors originating from the gums or alveolar processes, or from both, much depends on their character and the constitutional symptoms accompanying them. Some may be dispersed by simply extracting a decayed tooth or root; others will require extirpation, and, in some instances, even this will not avail. In short, the treatment must be varied to suit the respective circumstances of the case.

It sometimes happens, when an operation has been performed successfully, so far as regards the local disease, that the lungs, or some other vital organ, becomes affected. To prevent this, it is often necessary to get up, by means of a seton or issue, counter irritation in some neighboring part. Without this precaution, the life of the patient would often be put in as great danger as that from which it had escaped by the removal of the local disease.

On the extirpation of the fungous exostosis, or osteo-sarcoma, Sir Astley Cooper observes: "Amputation after constitutional means have been employed, and the continuance of these means after the operation, hold out the chief hopes of safety; for amputation without these, will do no more than avert the blow for a season."

These remarks will be found applicable to the treatment of the same description of disease, in whatever part of the body it may be situated. The constitutional symptoms should never be disregarded.

CHAPTER FOURTH.

ALVEOLAR ABSCESS.

As most of the phenomena attending the formation of alveolar abscess were noticed in the chapter on tooth-ache, it will not be necessary, in this place, to dwell upon them at much length. The periosteum of a tooth having become the seat of acute inflammation, plastic lymph is effused at the extremity of the root. This is condensed into a sac or cyst, which closely embraces the root near its apex, and as suppuration takes place, pus is formed in its centre. The inflammation, in the meantime, having extended to the gums and neighboring parts, they swell and become painful, and as the pus accumulates in the sac, it distends and presses upon the surrounding walls of the alveolus, which by a sort of chemico-vital process, are gradually broken down. By this means an opening is ultimately made through one side of the socket, when the pus, coming in contact with the investing soft structures, presses upon them and causes their absorption. Thus an outlet is effected for the escape of the accumulated matter.

The opening which gives egress to the pus, is usually in the gum opposite the extremity of the root, but the matter may escape from some other and more remote point. It may make for itself an opening through the cheek or through the base of the lower jaw, and be discharged externally; or it may pass up into the maxillary sinus, or through the nasal plates of the superior maxilla, or form a passage between the two plates of the bone, and escape from the centre of the roof of the mouth.

The formation of abscess in the alveolus of an inferior dens sapientiæ, is sometimes attended with inflammation and swelling of the tonsils and of the muscles of the cheek and neck. The author has known trismus to result from this cause.

The pain attending the formation of alveolar abscess, is deep seated, throbbing, and often so excruciating as to be almost in-

supportable. But as soon as suppuration takes place, it loses its severity, and with the escape of the pus nearly or altogether ceases; but the tooth, from the thickened condition of the alveolo-dental periosteum, particularly at the apex of the root, often remains sore and sensitive to the touch for several days. The energies of the disease, however, having been expended, the secretion of the pus, in the majority of cases, wholly ceases, and the opening in the gums closes. From the increased susceptibility in the alveolo-dental periosteum to morbid impression, occasioned by the presence of a tooth deprived of a large portion of its vitality, a recurrence of the inflammation is liable to take place, when pus will be again formed and the passage for its escape re-established. But the pain attending any subsequent attack, is seldom so severe as in the first instance.

There are some cases, however, in which the inflammation, instead of subsiding altogether, degenerates into a chronic form. In this case, the sac at the extremity of the root continues to secrete pus, though the quantity is usually small, and the opening in the gums remains unclosed.

In the extraction of a tooth which has given rise to the formation of abscess, the sac is often brought away with it. Two teeth in which this had happened, taken from the upper jaw, one a cuspid, and the other a first molar, are represented in the accompanying cuts, Figs. 162 and 163. In the case of the molar, the sac is attached to the palatine root. Both of these teeth were extracted previously to the formation of an external opening for the escape of the matter.

Fig. 162.

Fig. 163.

The time required for the formation of alveolar abscess, varies from three to ten or fifteen days, according to the violence of the inflammation. But a collection of pus may be detected by fluctuation under the finger, if applied to the tumefied gum, one or two days before an external opening is spontaneously formed for its escape.

The inflammation and pain attending the formation of abscess, in the socket of a tooth, often give rise to general febrile symptoms, headache and constipation of the bowels.

CAUSES.

The immediate cause of alveolar abscess is inflammation of the alveolo-dental periosteum, and this may arise from inflammation and suppuration of the lining membrane and pulp; or from an accumulation of purulent matter at the extremity of the root, the egress of which, through the natural opening, has been prevented. It may also be produced by mechanical violence, the irritation of a dead tooth, or by the presence of a portion of a gold filling forced through the fang of a tooth; as in the following case related to the author by his friend Prof. C. Johnston of Baltimore. A medical gentleman called upon a dentist of this city to treat a left first upper molar affected with caries. It was decided to remove the diseased pulp and introduce a fang filling, and accordingly the operation was undertaken; but in packing the first pellet in an external fang, the instrument suddenly slipped forward, and from this circumstance as well as from the pain, it became evident that the gold had passed out of the tooth. For nine months afterwards no inconvenience followed the operation, which was otherwise satisfactorily completed; when suddenly there appeared a soreness of the gum of the same tooth. Soon after a small tumor arose upon the face, half an inch above the left angle of the mouth, maturated, and burst spontaneously, discharging the erring pellet of gold. In a few days the opening closed, and a perfect cure resulted.

TREATMENT.

The treatment of alveolar abscess should be preventive, rather than curative, for it rarely happens, after it has occurred, that the integrity of the parts is so perfectly restored, as to prevent a recurrence of the affection. Although the secretion of pus may cease for a time, and the opening in the gums become obliterated, the tooth being deprived of a large portion of its vitality, is liable, whenever the excitability of the alveolo-dental periosteum is increased by any derangement of the general system, to give rise to a recurrence of the disease. The formation of abscess, therefore, should, if possible, be prevented by the use

of saline cathartics, the application of leeches to the gums, and a cooling regimen. By prompt antiphlogistic treatment the inflammation may sometimes be arrested. But should these means fail to prevent the formation of pus, the tooth, unless its retention is called for by some peculiar necessity, should at once be removed. If, however, as is often the case, the patient will not submit to the operation, the escape of the pus through the gum should be promoted by warm fomentations to the mouth. As soon as fluctuation can be perceived by applying the finger to the tumefied gum, an opening may be made with a sharp lancet for the escape of the matter. After this has discharged itself, the swelling of the gums and neighboring parts soon subside.

The application of fomentations and emollient poultices externally, are rarely productive of any advantage, and may do harm by promoting the discharge of matter through the cheek or lower part of the face. When this occurs, a depression with puckering of the skin is apt to remain after the escape of pus through the opening ceases and the orifice has closed, causing disfiguration of the face.

A very singular case of fistulous opening through the external integument is mentioned by Mr. Thomas Bell. It had resulted from an abscess in the socket of the right inferior dens sapientiæ, and the discharge of matter had been kept up for two years before he saw the patient. "At this time," says Mr. B., "a funnel-shaped depression existed in the skin, which could be seen to the depth of nearly three-quarters of an inch, and a small probe could be passed through it into the sac of the abscess, underneath the root of the tooth. The abscess had now remained open for two years, during the latter part of which time, the parts had been in the state I have described. I removed the tooth, and, as I anticipated, no further secretion of pus took place; but so perfectly had the communication been established, that when the gum healed, it left by its contraction a fistulous opening, through which a portion of any fluid received into the mouth passed readily to the outside of the cheek; and I could, by carefully introducing a fine probe, pass it completely through the passage. So free in fact was the communication, that some of the hairs of the whiskers, with which the external portion of the depression was filled, grew through the internal opening, and appeared in the mouth.

"I passed through it a very fine knife, resembling the couching-needle, and removed, as perfectly as possible, a circular portion of the parietes of the tube toward the gum; but failed in this, and several other attempts, to produce a union. It was, therefore, resolved that the whole parietes of the depression should be removed, extending the incision as far internally as possible; and the integuments thus brought together as a simple wound. In consequence, however, of the suppuration of a small gland in the immediate neighborhood, the operation was deferred until that should have been dispersed; it, therefore, remains at present in the state in which I have described it."

It rarely happens, however, that anything more is necessary for the cure of the external opening than the extraction of the tooth which had given rise to the formation of the abscess. The author has been consulted in many cases, and has never found it necessary to resort to other means; but should the external opening remain, the wall of the tube and depression may be removed in the manner just described.

The formation of an abscess in the alveolus of a lower wisdom tooth, is sometimes productive of very serious and even alarming consequences. The following is one of several similar cases which have fallen under the observation of the author.

In 1832, he was sent for in great haste to visit a physician who resided thirty miles in the country. He had been attacked two weeks before with severe pain in the left dens sapientiæ of the lower jaw. At the expiration of three or four days, a physician was called in, who made several unsuccessful attempts to extract the tooth.

The inflammation now extended rapidly to the fauces, tonsils and muscles of the jaw and face. Obstructed deglutition and a constant fever supervened, upon which repeated blood-lettings, cathartics and fomentations, applied to the face, had little effect. His respiration was difficult, and the muscles of his jaws soon became so rigid and firmly contracted that his mouth could not be opened.

This was the condition of the patient when the author first saw him, which was the morning of the day following the one on which he was sent for. In addition to the treatment which had previously been pursued, an injection with two grains of

emetic tartar was administered. About seven o'clock in the evening, the fever was succeeded by alternate paroxysms of cold and heat. An effort was now made to force open his mouth with a wooden wedge. This was partially successful, but his teeth could not be forced asunder sufficiently to admit of the introduction of the smallest sized tooth-forceps. But while his jaws were thus partially separated, he attempted to swallow some warm tea; in the effort an abscess burst and discharged nearly a tablespoonful of pus from his mouth, and it was supposed that double that quantity passed down into his stomach. This gave immediate relief, but it was not until about three o'clock in the afternoon of the next day that his jaws could be forced apart sufficiently to permit the extraction of the tooth which had caused the trouble. To the roots of this, which were united, there was attached a sac about the size of a large pea, filled with pus. The patient recovered rapidly, and in a few days was quite well.

The following is the most singular case of alveolar abscess which has ever fallen under the observation of the writer: The subject was a lady about thirty years of age. She had been troubled with a dripping of pus from behind the curtain of the palate for about twelve months, and becoming somewhat alarmed at its continuance, she called the attention of her family physician, Professor Bond, to it, who carefully examined the case, and endeavored to ascertain the place from whence the matter came. He soon satisfied himself that it was from the socket of a diseased tooth. Upon passing his finger around on the gums covering the superior alveolar border, he discovered a protuberance over the root of each upper central incisor, nearly as large as a hazel-nut. This tended to confirm the opinion which he had formed as to the source from whence the matter came, and he requested us to visit the lady with him, which we did on the following day. On examining the case, we advised the immediate removal of the affected teeth, and the more strongly as they were found to be in a necrosed condition.

The lady readily consented to the operation, which was performed on the following day. The discharge of matter from behind the curtain of the palate immediately ceased, and the patient was relieved from an affection which had been a source

of great annoyance. The pus from the abscess, in this case, instead of passing out through the nasal plates of the superior maxilla, passed back over the roof of the mouth, and escaped in the manner described.

The author was lately consulted in a case of a similar character to the one last noticed. The pus had found its way from the socket of a first superior molar to about the centre of the palatine arch, thence passed up into the posterior nares, and was discharged from behind the velum palati.

Inflammation of the investing membrane of the roots of an inferior dens sapientiæ may produce equally serious effects, without occasioning the formation of an abscess in the alveolus. The eruption of these teeth are sometimes attended with like consequences. The irritation has, in some instances, extended to the lungs, and even been, in decidedly consumptive persons, the exciting cause of consumption.

The occurrence of alveolar abscess in the socket of a temporary tooth is often followed by exfoliation of the sockets of several teeth, and sometimes of considerable portions of the jawbone, seriously injuring the rudiments of the permanent teeth, and sometimes causing their destruction. The author saw a case, a few years since, in which an abscess of the alveolus of the first lower temporary molar had occasioned exfoliation of the sockets of a cuspid and two molars. About one-half of the alveolar cells of the two bicuspids and the cuspid of the second set were also exfoliated, thus leaving their imperfectly formed crowns entirely exposed.

When the inflammation of the alveolo-dental periosteum results from inflammation of the pulp and lining membrane, the formation of abscess may be prevented by the prompt destruction of the latter with arsenious acid, cobalt or chloride of zinc. If any attempt is to be made to secure the preservation of the tooth, this should be promptly done, as the chances of success are always greater previously to the formation of an abscess than afterward. But for a description of the treatment in such cases, the reader is referred to the chapter on filling the pulp-cavities and roots of teeth.

CHAPTER FIFTH.

NECROSIS AND EXFOLIATION OF THE ALVEOLAR PROCESSES.

The alveolar proeesses, as well as other osseous struetures, are liable to neerosis or loss of vitality. When their eonneetion with the periosteum—the souree from whence they derive their nourishment and vitality—is destroyed, death follows as a ncees-sary conscquenec. The loss of vitality may be confined to the socket of a single tooth, but more frequently it extends to several, and sometimes to the entire alveolar border, oecasionally includ-ing a part or the whole of the jaw. It may oecur in either jaw, but it is more liable to take place in the lower than the upper. When confined to the alveoli, the dead part is never replaeed with new bone, but examples are on record of the regeneration of a part, and even the whole of the lower jaw. It is, however, denied by some, that thc loss of any portion of this bone is ever replaced with true osseous structure.

When one or more of the soekets of the teeth lose their vitality, nature exerts all her energies to separate the dead from the liv-ing bone; this proeess, technically termed *exfoliation*, is supposed by some to eonsist in a sort of suppurative inflammation, but there is reason to believe it is effectcd by the action of a corro-sive fluid poured out from the fungous granulations of the living bone in immediate eontaet with the neerosed part. During the process of exfoliation, a thin aerid matter is discharged from one or more fistulous openings through thc gums or from betwcen them and the necks of thc tceth; the gums having lost thcir con-nection with the necroscd bone, beeome soft and spongy, and assume a dark purplc appearancc, are preternaturally sensitive to the touch, and bleed from thc most trifling injury.

In the admirable work of Mr. Fox, on the Natural History and Diseascs of thc Teeth, thcre arc two engravings of exfoliated alveolar proeesscs. The first represents thc alveoli of a central

and lateral incisor and that of the left cuspid, with a portion of the maxilla, extending about five-eighths of an inch above the apex of the roots of the last mentioned tooth. The subject in this case was a gentleman whose left lateral incisor became carious; inflammation and pain ensued, together with swelling of the gums and lip. Instead of consulting a physician, he applied poultices to his face, until suppuration in the alveolus took place, causing the formation of an external opening through the gums for the discharge of the matter. After his mouth had remained for some time in this condition, he applied to Mr. Fox, who, upon examination, found that not only had the decayed tooth become loose, but also one on each side of it. The first he extracted, and discovered that the alveolus, from the destruction of its periosteum, was quite rough. The adjoining teeth, still continuing loose, were in a few weeks removed, and the slight force that was applied, brought with them the alveolar processes of the whole of the three teeth, and also a considerable portion of the jaw-bone. The other engraving represents an inferior molar and two bicuspids, with their sockets and a very large piece of jaw-bone. The necrosis and exfoliation in this case, as in the other, was produced by alveolar abscess.

The author has met with several very similar cases, though all were not produced by the same cause, and he has several specimens in his possession, two of which were presented to him by his late brother, Dr. John Harris.

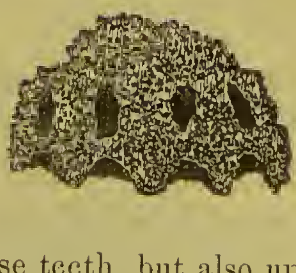
The author has met with two cases of necrosis and exfoliation of the alveolar processes, which are worthy of special notice. The subject of the first case, was a gentleman of a strumous habit, about thirty years of age; the necrosis and exfoliation extended to the sockets of all the teeth in the upper jaw. In May, 1851, he had the nerve destroyed in the second bicuspid, on the right side of the superior maxilla. We believe it was afterward removed, and the pulp-cavity and root filled. About six weeks after, as nearly as we could ascertain, the socket of the tooth became slightly painful, but as his suffering was not constant, he supposed it would soon cease. The pain, ultimately, however, began to increase, and by the latter part of the following September was so severe, and attended by so much constitutional disturbance, that he was induced to consult a physician.

After having been under medical treatment for about two weeks, the author was requested by the medical attendant to see him. The affected tooth was found to be loose, and its socket in a necrosed condition; inflammation had extended to every part of the alveolar border; the gums were very much swollen, and nearly all the teeth sensitive to the touch. As the patient was laboring under considerable cerebral derangement, and as no advantage could be derived from the removal of the tooth at this time, it was deemed advisable to let it remain until exfoliation of the necrosed socket should take place.

Without going into a detailed description of the local and constitutional treatment subsequently pursued, it will be sufficient to state that necrosis extended to the sockets of all the other teeth, except those of the second and third molars on each side of the mouth. In the course of about two months, twelve teeth, together with their exfoliated sockets, and several large pieces of the maxillary bone were removed. It was hoped that the disease would stop here, but in three or four weeks the four remaining molars became very sore to the touch, and as purulent matter began to be discharged from their sockets, it became necessary to remove them. Several small pieces of bone were exfoliated after the last operation, but at the expiration of about four months from this time his mouth was sufficiently restored to enable him to wear a temporary set of artificial teeth.

The subject of the second case was a lady of a cachectic habit, about thirty-five years of age. The necrosis resulted from inflammation of the alveolo-dental periosteum, occasioned by irritation produced by the roots of the four upper incisors, upon which pivot teeth had been placed, which, however, had been removed some two or three weeks before the author saw the patient. At this time the necrosis had extended not only to the sockets of these teeth, but also up to the nasal crest of the maxillary bone, and the process of exfoliation had already proceeded so far, that he was enabled to remove the entire piece, the appearance of which is represented in Fig. 164. In July, 1852, a few weeks after the removal of this piece, he again saw the patient, and, on examination, found

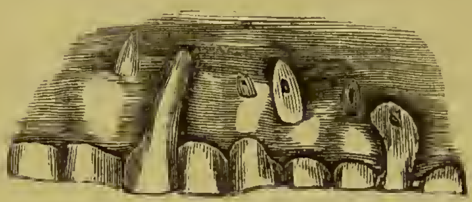
Fig. 164.



a large portion of the palatine plate of the bone in a necrosed state, but the process of separation had not yet proceeded far enough to enable him to remove it.

The accompanying engraving, made from a drawing furnished the author by Dr. Maynard, represents a case of necrosis and exfoliation of a portion of the outer wall of the alveolar ridge, and the consequent protrusion of the roots of the teeth on one side of the mouth. The only facts which Dr. Maynard had been able to procure in relation to this case were contained in the patient's statement: "That in 1818 he took a cold, which settled in his upper jaw, and a large piece of the jaw-bone came away." The cast from which the drawing was made was taken in 1840; at which time the doctor cut off the apices of several fangs which projected from the gums.

Fig. 165.



CAUSES.

The immediate cause of necrosis is the death of the periosteum, occasioned by inflammation. The cause of this, as has already been shown, is, in a large majority of the cases, dental irritation. Necrosis of the alveolar process occurs very frequently while the system is under the influence of mercurial medicines, and during bilious and inflammatory fevers, and certain other constitutional diseases, as syphilis, small-pox, etc. It may also result from mechanical injuries.

TREATMENT.

In the treatment of cases of this kind, little can be done. As soon, however, as the dead portions of bone become separated from the living, and can be easily removed, they should be taken away with a pair of forceps. To correct the offensive odor and disagreeable taste occasioned by the constant discharge of fetid matter, a wash of dilute chlorinated soda, or of the tincture of myrrh, may be employed; but for any other purpose than this, we have not been able to perceive that local applications were of much advantage. Should constitutional symptoms supervene, tonics and a generous diet may be recommended.

CHAPTER SIXTH.

GRADUAL DESTRUCTION OF THE ALVEOLAR PROCESSES.

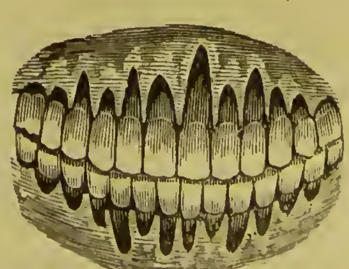
WHILE treating of inflammation and tumefaction of the gums, the author adverted to the wasting of the sockets of the teeth, taking occasion to express a doubt that such operation of the economy ever manifested itself in the absence of all local disease.

It is always accompanied by a slight increase of redness, tumefaction and a shrinking of the edges of the gums (ulatrophia); but the diseased action here is so inconsiderable as to attract little attention. It is also attended by a slight discharge of purulent matter from between the margin of the gum and the tooth, but the quantity is so small that it usually escapes observation. The alveolo-dental periosteum participates also in the diseased action, but this is so slightly affected that the tooth often remains quite firmly articulated, after the wasting of its socket has proceeded even so far as to expose more than half of the root. Indeed the affection is so closely allied to chronic inflammation and tumefaction of the gums, as scarcely to require separate consideration.

The progress of the disease is usually so slow that ten, fifteen, or twenty years are required to affect very perceptibly the stability of the teeth in their sockets. The commencement of this destructive process is usually first observed around the cuspid teeth; sometimes it makes its first appearance on the alveoli of the palatine roots of the first and second upper molars, and occasionally it goes on here for years before it affects the sockets of any of the other teeth.

The teeth after their roots have been partially exposed, become, as might naturally be supposed, more susceptible to impression from heat and cold and more easily affected by acids, or saccharine matters; but this is about the only manifest inconvenience experienced from the disease, until the teeth begin to loosen in their sockets.

FIG. 166.



In Fig. 166 is represented a case in which the roots of the

teeth have become considerably exposed by the gradual wasting of their sockets: the destruction being, as is usual, greatest toward the median line.

CAUSES.

The cause of this peculiar affection has never been very satisfactorily explained. Some have supposed that, inasmuch as it occurs most frequently in persons of advanced age, it results from a decline of the vital powers of the body, independently of local causes. But, as it is often met with in middle-aged persons whose constitutional health is unimpaired, we doubt the correctness of the opinion. In all cases which have come under our observation, whether in middle-aged or very old persons, the teeth indicated an excellent innate constitution, whatever may have been the state of the general health at the time. In every instance these organs were possessed of great density, and this fact is particularly noticed by Mr. Fox, who says:

"In a majority of cases in which this disease occurs, the teeth are perfectly sound, and from numerous observations, we think we may venture to assert, that persons who have had several of their teeth affected with caries in the earlier part of life, are not liable to lose, by an absorption of their sockets, those which remain sound; but, where the teeth have not been affected with caries in the early part of life, persons, as they approach the age of fifty, and often much earlier, have their teeth becoming loose from absorption, or a wasting of the alveolar process."

Now it is evident that teeth endowed with the power of resisting to so late a period of life the action of the causes of decay, to which all teeth are more or less exposed, must be possessed of extreme density, and, necessarily, a correspondingly low degree of vitality. In view of this fact, we have been led to the opinion that the teeth themselves may act, to some extent, as mechanical irritants to the more highly vitalized parts with which they are immediately connected, causing an increase of vascular action in the periosteum of the thin edges of the alveoli and margin of the gums. This abnormal condition is attended by a slight secretion of purulent matter observed between the edges of the gums and teeth. It is to the corrosive action of this purulent matter that the gradual destruction of the alveoli has by some

been attributed; but it is more probably a result of the obscure disease than its cause.

We were for a long time inclined to ascribe the increase of vascular action in the edges of the gums and alveolo-dental periosteum to irritation produced by the pressure of the teeth against the alveolar septa; but having met with many cases where the teeth were not crowded, we were induced to enter into a more thorough examination of the possible causes, and the foregoing is the only conclusion to which we have been able to arrive.

TREATMENT.

From what has been said concerning the cause of this affection, it is obvious that a cure cannot be effected. The secretion of the purulent matter, to the action of which some attribute the destruction of the alveoli, is the result of a disease in the alveolo-dental periosteum and edges of the gums, arising from some peculiar physical condition of the teeth; the most we can hope to accomplish is to retard its progress. This can only be done by cleaning the teeth frequently and thoroughly, using the precaution each time to remove the purulent matter from between the edges of the gums and teeth, lest, if allowed to remain, it should become putrescent, and in this condition act as an irritant to the gum. For this purpose a brush with elastic bristles should be used, and much benefit will be derived by passing floss silk several times a day up and down between the teeth.

CHAPTER SEVENTH.

DISPLACEMENT OF THE TEETH BY A DEPOSIT OF OSSEOUS MATTER IN THEIR SOCKETS.

A TOOTH is sometimes slowly forced from its place by a deposit of bony matter in the bottom or on the side of the socket. Two, or even three teeth, may be gradually displaced, at the same time, by exostosis of the alveoli. The deposition usually proceeds so slowly that one or two years are required to effect a very perceptible change in the situation of a tooth. The upper central incisors are more frequently affected than any of the other teeth, and the deposit occurs oftener at the bottom than on the sides of the alveoli. In the first case, the tooth is gradually protruded from the socket; in the other, it is either pressed out of the arch, or against one of the adjoining teeth. Irregularity in the arrangement of the teeth is, in this manner, sometimes produced, especially when more than one socket is affected at the same time. The central incisors are sometimes forced apart; at other times they are forced against each other, and caused to overlap. The deposition of bone, however, being generally confined to the bottom of the sockets, the teeth are more frequently thrust from their alveolar cavities. When this occurs with a person whose upper and lower teeth strike directly upon each other, it occasions much inconvenience; for the elongated tooth must either be thrown from the circle of the other teeth, or, by striking its antagonist, prevent the jaws from coming together.

CAUSES.

So little is known concerning the cause of exostosis of the sockets of the teeth, that it may seem almost useless to attempt an explanation of it. That it results from some irritation of the lining membrane is very generally believed, but what causes the irritation does not seem to be well understood. We have thought

that it might sometimes be produced by pressure on the bottom of the alveolus, especially when the extremity is nearly as large as any other part of the root of the tooth. The susceptibility of the lining membrane to morbid impressions may sometimes be so great that the pressure of a very conical root may be sufficient to produce this effect; or, it may be produced by the pressure of a tooth which possesses only a very low degree of vitality. But in connection with this class of cases must be taken another, in which absence of all pressure would seem to be an inciting cause of alveolar exostosis; as where a tooth has lost its antagonist tooth or teeth, and in consequence becomes elongated. A diseased state of the gums can have no agency in the production of the exostosis, for it most frequently occurs in individuals whose gums are perfectly healthy; and if it were the result of any consitutional tendency, all the teeth would be as likely to be affected by it, as those we have mentioned.

TREATMENT.

When the exostosis is on the side of the alveolar cavity, the tooth cannot be restored to its natural position; but when it is in the bottom of the socket, the elongated organ may from time to time, as it is forced from the alveolus, be filed off even with the other teeth; but in doing this care should be taken to avoid as much as possible the unpleasant jar which the file is so apt to cause, and which might, in such cases, excite the periosteum to increased activity and a more rapid deposit. This will remove the deformity and prevent its displacement by the antagonizing tooth. By this simple operation, repeated as occasion may require, it may be preserved for years, and rendered almost as useful as any of the other teeth.

PART FIFTH.

DISEASES OF THE MAXILLARY SINUS, AND THEIR TREATMENT.

PART FIFTH.

CHAPTER FIRST.

PRELIMINARY REMARKS.

It was not until the knowledge of anatomy had made considerable progress that the existence of this cavity was known. Casserius, an anatomist of Padua, is supposed to have been the first to discover it. He flourished during the latter part of the sixteenth and early part of the seventeenth centuries; but no correct description of it was given until about the middle of the latter; the credit therefore of this discovery is given to Nathaniel Highmore, author of a treatise on anatomy, published in 1651. Hence its name, "*antrum Highmorianum.*"

This cavity is subject to some of the most formidable and dangerous diseases the medical or surgical practitioner is ever called upon to treat; and yet there are few diseases incident to the human body, that have received less attention from writers on pathology and therapeutics than these. There are diseases here met with, over which neither the surgeon nor physician can exercise any control, the progress of which ceases only with the life of the unfortunate sufferer.

All of the diseases to which the maxillary antrum is subject, however, are not of so dangerous a character, for some are very simple and easily cured; but even those which are regarded as the least dangerous, and which yield most readily to treatment, when instituted during their incipient or earlier stages, may assume, if neglected, or improperly treated, a form so aggravated as to bid defiance to the skill both of the physician and surgeon. While thus, on the one hand, the most simple affections of this cavity, may, by neglect or improper treatment, become ultimately

incurable; many of those on the other hand, which are considered the most malignant and dangerous might, we have no doubt, by timely and judicious treatment, be effectually and radically removed.

The form which the disease puts on, is determined by the state of the constitutional health or some specific tendency of the general system; and we can readily imagine, that a cause which, in one person, would give rise to simple inflammation of the lining membrane, or mucous engorgement of the sinus, would, in another, produce an ill-conditioned ulcer, fungus hæmatodes, or osteo-sarcoma. Simple inflammation and mucous engorgement not unfrequently cause caries and exfoliation of the surrounding osseous tissues, and, in some instances, even the destruction of the life of the patient.

The importance of early attention to the diseases of this cavity is, therefore, very apparent; and this is the more necessary, as it is often difficult, and sometimes impossible, to determine the character of the malady, until it has progressed so far as to involve, to a greater or less extent, the neighboring parts; when, if it has not become incurable, its removal is, to say the least, rendered less easy of accomplishment. It may be safely assumed, therefore, that in a very large majority of the cases of disease of the maxillary sinus, the danger to be apprehended arises more from neglect than from any necessarily fatal character of the malady, so that, in forming a prognosis, the circumstances to be considered are, the state of the constitutional health, the progress made by the affection, and the nâture of the injury inflicted by it upon the surrounding tissues. If the general health is not so much impaired as to prevent its restoration by the employment of proper remedies, and the neighboring structures have not become implicated, the prognosis will be favorable; but if the functional operations of the body have become very much deranged, and the bones of the face and nose seriously affected, the combined resources both of medicine and surgery will prove unavailing.

In young and middle aged subjects of good constitution, a morbid action may exist in the antrum for years, without giving rise to any alarming symptoms, while the same affection in another less healthy, might rapidly extend and degenerate into

a form of disease so malignant as to threaten the speedy destruction of the life of the patient. Medical history abounds with examples of this kind, and conclusively establishes the fact that the state of the general health and habit of body, whatever may have been the primitive characteristics of the malady, ultimately determines its malignancy; in the treatment of affections of this cavity, therefore, as well as of other local diseases of the body, the condition of the system should not be overlooked.

Independently of the danger arising from the local affection, diseases of the antrum are, for the most part, very loathsome, and subject the patient to great annoyance. They change the quality of its secretions, and cause them to exhale a fetid, nauseating odor. This, in many instances, is almost insufferable to the patient; and when they are prevented from escaping through the natural opening into the nose, they pass through one artificially formed by the surgeon, or made by the disease through the cheek, alveolar border, or palatine arch, always causing the patient great inconvenience.

The progress of disease in this cavity is often very insidious. It not unfrequently happens that it exists for weeks and even months before its existence is suspected. The slight uneasiness felt is attributed to some morbid condition of the teeth or gums, and the symptoms attendant upon one description of affection are often so similar to those that accompany another, that it is impossible to determine its true character until it has made considerable progress.

The morbid affections of the maxillary sinus are, for the most part, similar to those of the nasal fossæ. There is, however, one form of disease which seems to be peculiar to this cavity, viz., mucous engorgement. Deschamps mentions two kinds of accumulations, dropsical and purulent;* but the first of these is, properly speaking, a disease of serous membranes, and is never met with in this cavity; and authors who have enumerated it among its diseases, have evidently mistaken mucous engorgement for it. The fluids that accumulate here are of a mucous or muco-purulent character, except when they are the result of the disorganization of some of the surrounding parts; then they are sanious.

* Traitè des Maladies des Fosses Nasales et les leurs Sinus; p. 226.

The most simple form of disease that occurs here, is inflammation of the lining membrane, and this in most instances may be said to precede all others. It often subsides spontaneously, but when it continues for a long time, is apt to become chronic, and may then give rise to other and more formidable kinds of disease. When unattended by any other morbid affection, either local or constitutional, it is easily cured.

A purulent condition of the fluids of the antrum is a common affection, but is seldom met with in persons of good constitution. It seems to be dependent upon a bad habit of body; also upon inflammation of the mucous membrane of the sinus, which arises more frequently from dental irritation than any other cause. This condition of the secretions sometimes gives rise to caries and exfoliation of portions of the surrounding bone, and to fistulous ulcers; but when dependent upon no other local cause than simple inflammation of the mucous membrane, it is seldom that such effects result from it. When complicated with other morbid conditions of the cavity, they are not unfrequent.

All purulent secretions of this membrane, are by some denominated abscess. The name, however, as is justly remarked by Mr. Thomas Bell, is improper. The term abscess is more correctly applied to purulent collections in the areolar tissue—either sub-mucous, sub-serous, sub-cutaneous, inter-muscular or parenchymatous. It seldom originates in the sub-mucous tissue of the antrum, but proceeds occasionally from disease in the cancellated structure of the surrounding bones. Instances of it have been met with at the extremities of the roots of teeth which had perforated the sinus; and it sometimes happens that when an abscess is seated in the alveolus of a superior molar, the matter, instead of making for itself a passage through the socket of the tooth on either side, escapes into this cavity, and thence with the antral secretions, through the nasal opening. Mr. Bell describes a case of abscess seated in the upper part of the antrum; but this, and one other, are the only examples of the kind on record.

Ulceration of the lining membrane is an affection less frequently met with. It is rarely, if ever, idiopathic, but seems rather to be dependent upon some other local malady or some specific constitutional vice. Scorbutic and scrofulous diatheses,

and those affected with a venereal taint, are more liable to ulceration of this membrane than persons of sound constitution. Consequently, it is seldom cured by local remedies alone. It is almost always complicated with fungus of the membrane and caries of the walls of the sinus, and may if neglected take on a cancerous form and become incurable.

The next form of disease is caries of the antral parietes. This, though always complicated with other forms of diseased action, seems, nevertheless, to be worthy of separate consideration. Like ulceration of the lining membrane, it is the result of some other affection. It may result from accumulation of the secretions of the sinus, from ulceration, or from tumors.

The occurrence of fungus and of various kinds of tumor is less frequent than any of the preceding affections; yet this cavity is not exempt from them, and they constitute the most dangerous form of disease to which the superior maxilla is subject. Although it is probable, that in their incipient stage, they might in nearly every instance be radically removed, it is seldom they are cured after they have attained a very large size, and have implicated, to considerable extent, the surrounding tissues. They have, however, been successfully extirpated even after they had acquired great volume, and implicated to such an extent the surrounding parts, as to render necessary the removal of the whole of the superior maxillary bone. They usually grow with great rapidity, and if not completely removed, are soon reproduced.

Besides these, other varieties of disease are occasionally met with here. The antrum is liable to injuries, from blows and other kinds of mechanical violence, and from the introduction of insects and foreign bodies; but of these, it is not necessary to speak in this place, as they will hereafter come up for special consideration. The diseases of the maxillary sinus are supposed to be dependent upon certain specific constitutional vices; upon the obliteration of the opening of this cavity into the nose; and upon dental irritation. That all of these may, at times, be concerned in their production, is more than probable. But actual disease rarely developes itself spontaneously as a consequence merely of a bad habit of body or constitutional vice. This does not of itself originate disease, but only occasions an increase of

susceptibility of the tissues to morbid impressions; so that when an unhealthy action is once induced here, a more aggravated, or a different form of disease occurs than that which would otherwise have been produced.

Thus it may be seen, that disease of the maxillary sinus is dependent upon some exciting cause, favored by some constitutional vice; for without this, no serious morbid effects would be produced, or if produced, they would be of a different and less aggravated character. Any disposition or vice of body, which weakens the vital energies of the system, increases the susceptibility, or rather *excitability* of all its parts—those of this cavity equally with the rest. There are various kinds which have this effect: as, for example, the scorbutic, scrofulous, venereal, mercurial, etc., each of which may influence the character of the morbid action in a mannner peculiar to itself; or it may be similar to that which might be exercised by another, only causing it to assume a greater or less degree of malignancy, accordingly as the functional operations of the body generally are more or less enervated by it.

This seems to be the way in which a bad habit of body is capable of affecting the maxillary sinus. It is a predisposing, but not an exciting cause of disease; and it is important that this distinction should be borne in mind. The one should never be confounded with the other, because an error of this sort might, in many instances, lead to the adoption of incorrect views concerning the therapeutical indications of the disease. This part of the subject we shall have occasion to advert to hereafter.

Inflammation and ulceration of the nasal pituitary membrane sometimes extend themselves to the maxillary sinus; but disease is not so frequently propagated from the nasal fossæ to this cavity as the intimate relationship between the two might lead one to suppose. It is seldom that both are affected at the same time. Hence we infer, that, although lined by one common membrane, the propagation of disease from one to the other is a rare occurrence.

The obliteration of the nasal opening of this cavity is sometimes caused by disease in the nose, and is followed by mucous engorgement of the sinus, inflammation of the lining membrane, distension of the osseous walls, and not unfrequently by other and more complicated forms of disease. But the closing of this opening is oftener an effect than a cause of disease in this cav-

ity, and it generally re-establishes itself without any assistance of art, after the cure of the affection which caused it.

If all the circumstances connected with the history of the diseases under consideration could be ascertained, we think it would be found that these affections are more frequently induced by a morbid condition of the teeth, gums and alveolar processes, than any other cause. There are, in fact, no sources of irritation to which this cavity is so much and so often exposed as those arising from the dental organism. It is separated from the apices of the roots of the superior molars and bicuspids by only a very thin plate of bone, and is sometimes even penetrated by them; so that it could scarcely be otherwise than that aggravated and protracted disease in the teeth and alveoli should exert an unhealthy influence upon it. The pain occasioned by diseased teeth is often very severe, sometimes almost excruciating, and inflammation in the alveolo-dental periosteum and gums frequently extends itself to the whole of one side of the face. It could hardly be possible, therefore, for this cavity to escape. Alveolar abscess, and sometimes necrosis and exfoliation of the socket of the affected tooth, arise from the inflammation thus lighted up. It often happens that the gums and alveolar periosteum are affected for years with chronic inflammation and other morbid affections.

If, in addition to these facts, other proofs be necessary to establish the agency of dental and alveolar irritation in the production of disease in the maxillary sinus, they may be found. Many of the affections here met with are often cured by the removal of diseased teeth after other remedies have been employed in vain, and that without even perforating the antrum. This would not be the case if the irritation did not arise as a consequence of the dental malady.

Most writers on diseases of the sinus agree in ascribing them to a morbid condition of the teeth and alveoli. There are some, however, who, though they admit that dental irritation may, perhaps, occasionally give rise to them, seem, nevertheless, to attribute their occurrence, in the majority of instances, to other causes, such as irregular exposure to cold, blows upon the face, and certain constitutional diseases. We shall now proceed to the consideration of the different affections of this cavity, under their respective and appropriate heads.

CHAPTER SECOND.

INFLAMMATION OF THE LINING MEMBRANE OF THE MAXILLARY SINUS.

Inflammation, when not complicated with any other morbid affection, is the most simple form of disease to which the pituitary membrane of the antrum is subject. As it precedes and accompanies all others, it will be proper to offer a few remarks upon it, before entering upon the consideration of those of a more aggravated nature.

Inaccessible as it is here to most of the acrid and irritating agents to which it is exposed in the nasal fossæ and some other cavities of the body, it would rarely become the seat of inflammation, were it not for its proximity to the teeth and alveolar border; and simple inflammation rarely gives rise to any other form of diseased action, unless favored by some general morbid tendency, but usually subsides spontaneously on the removal of the exciting cause. In good constitutions, it is less subject to inflammation, and consequently, to any other description of morbid action, than those in whom there exists some vice of body, or constitutional predisposition. Febrile and gastric affections; eruptive diseases, such as measles, small pox, etc.; syphilis, and excessive and protracted use of mercurial medicines; a scorbutic or scrofulous diathesis of the general system; in short, everything that has a tendency to enervate the vital powers of the body, increases its irritability.

When in a healthy condition, it secretes a slightly viscid, transparent and inodorous fluid, by which it is constantly lubricated, but inflammation changes the character of the secretion; it causes it to become vitiated; at first less abundant, it is afterwards secreted in larger quantities than usual, becomes more serous, and so acrid as sometimes to irritate the membrane of the nose, over which it passes after having escaped from the antrum. It also exhales an odor more or less offensive, accordingly as the inflam-

mation is mild or severe. It moreover gives rise to a thickening of the membrane, and sometimes to obliteration of the nasal opening. This last rarely occurs, but when it does happen, an accumulation of the secretion and other morbid phenomena of which we shall hereafter treat, result as a necessary consequence.

If at any time during the continuance of the inflammation, the patient is attacked with severe constitutional disease, the local affection will be aggravated, and sometimes assume a different character.

The inflammation, when long continued, degenerates into a chronic form, and is sometimes kept up for several years, without giving rise to any other unpleasant symptoms than occasional paroxysms of dull and seemingly deep-seated pain in the face, and a vitiated condition of the fluids of this cavity. The slightly fetid odor which they exhale, ceases to be annoying or even perceptible to the patient, when he becomes accustomed to it.

SYMPTOMS.

The symptoms of inflammation here, though not always precisely the same as elsewhere, are, for the most part, very similar. They are severe, fixed, and deep-seated pain under the cheek, extending from the alveolar border to the lower part of the orbit; local heat, pulsation and sometimes fever. Beyer says these symptoms are not always present, and that inflammation may exist when it is not suspected. Other affections of the face and superior maxilla, may be mistaken for this, and this for others; but that inflammation should exist without being attended with pain or any other signs indicative of its presence, is scarcely probable.

Deschamps distinguishes the symptoms of this from those of other affections of this cavity, by a dull, heavy pain in the region of the sinus, which, he says, becomes sharp and lancinating, and extends from the alveolar arch to the frontal sinus. The disease goes on without interruption, increasing until the superior maxilla of the affected side is more or less involved. This malady, he says, cannot be confounded with any other, even where there is no external visible cause; differing from a simple retention of mucus, by being painful at the commencement, and by not being

accompanied with swelling of the bones; from polypus, by the continuance of pain; and from cancer, by the character of the pain. "Suppuration and ulcers have peculiar signs which cannot be confounded with those of inflammation." Pain in the molar and bicuspid teeth, accompanied by a sense of fluctuation in the parts, he seems to regard as a very certain indication of inflammation, and, especially, when joined to the other symptoms. "If an external cause is discovered, it will furnish a certain diagnosis;" he also mentions fever and headache as almost invariable accompaniments.

The inflammation, if not subdued by appropriate remedies, after having continued for a length of time, gradually assumes a chronic form; the pain then begins to diminish, and is less constant; it becomes duller, and is principally confined to the region of the antrum. The teeth of the affected side cease to ache, or ache only at times, but still remain sensitive to the touch. The mucous membrane of the nostril next the diseased sinus, is often tender and slightly inflamed; and if in the morning, or after two or three hours' sleep, the other nostril be closed by pressing upon it with the thumb or one of the fingers, and a violent expiration be made, a thin watery fluid, of a slightly fetid odor, will be discharged, and pain will be experienced in the region of this cavity.

CAUSES.

All morbid conditions of the teeth and gums, causing irritation in the alveolar periosteal tissue, may be regarded as among the most frequent of its exciting causes, especially caries, necrosis, and exostosis; also, loose teeth, and the roots of such as have been either fractured in an attempt at extraction, or by a blow or fall, and left in their sockets, or that have remained after the destruction of their crowns by decay. It sometimes happens, too, that inflammation is excited in this membrane by fractured alveoli; but when an accident of this sort occurs, the detached portions of bone are generally soon thrown off by the economy, and the cause being removed, the inflammation immediately subsides. Not so with the roots of the teeth. They often remain concealed in their sockets for years, unless removed by art.

Nature, it is true, makes an effort to expel them from the jaw, but this is accomplished only by a slow and very tedious process, and not, in many instances, until they have given rise to some serious affection. But of the deleterious effects that result from necrosed roots of teeth in the alveoli, it is not necessary now to speak; as extraneous bodies, they are always productive of more or less irritation. We might also mention exposure to sudden transitions of temperature, and certain constitutional diseases, as among the causes which occasionally give rise to inflammation of this membrane.

TREATMENT.

The curative indications of inflammation of the lining membrane of the antrum are simple, and, for the most part, similar to those of inflammation in other parts of the body. Bleeding from the arm, saline purgatives, and fomentations to the face, and other antiphlogistic measures, may be resorted to with advantage. In many cases, great benefit will be derived from the application of leeches to the cheek, as recommended by Mr. Thomas Bell. When the disease is dependent, as in most instances it is, upon an unhealthy condition of the alveolar processes, the first thing to be done is to remove all such teeth, or roots of teeth, as are productive of the least irritation; for while any local sources of irritation are permitted to remain, neither topical nor general bleeding, or indeed any other treatment, will be of permanent advantage.

Simple inflammation of the lining membrane of the antrum, would be of little consequence, were it not that it is liable to give rise to other and more dangerous forms of disease, such, for instance, as engorgement or a purulent condition of its secretions. It should never, therefore, be permitted to continue, but be as speedily arrested as possible; and for the accomplishment of this, the means here pointed out, will, if timely and properly applied, be found fully adequate.

CHAPTER THIRD.

PURULENT CONDITION OF THE SECRETIONS AND ENGORGEMENT OF THE MAXILLARY SINUS.

A PURULENT condition of the secretions of the maxillary sinus and mucous engorgement are, indiscriminately, though very improperly, denominated by many writers on the affections of this cavity, abscess. To this, neither bears the slightest resemblance. Deschamps treats of the former under the name of suppuration, and the latter, dropsy. Of the first, he says, "If by the time the inflammation has passed, the surrounding parts cease to be painful, while the affection still continues to cause pain in the antrum, and the fever, though diminished, occurs at irregular intervals, and if the inflammation is followed by pulsating pain, we have reason to suppose that an abscess has formed in the sinus; and all doubt will be removed, if, on the patient's inclining his head to the opposite side, matter is discharged into the nostrils, or if some tubercles are formed near the outer angle of the eye, or alveolar border, which last happens more frequently; and, finally, if the purulent matter, not finding any opening through which to discharge itself, distends the sinus to such an extent as to form a tumor outwardly upon the cheek." In short, all the symptoms which he mentions as belonging to the disease, are those accompanying the one under consideration. The matter, he says, is of a "putrid serous consistence."

Bordenave has fallen into a similar error. He terms an altered state of these secretions, suppuration of the membrane, and says that inflammation is not necessary to it. He seems to have confounded with abscess of the antrum those cases of alveolar abscess where the matter, instead of discharging itself, as it ordinarily does, by an opening through the alveolus and gum into the mouth, passes into that cavity. Again he asserts that the disease (suppuration as he calls it) may be independent of the surrounding parts; and although ordinarily implicated with

an altered condition of them, he affirms, it is sometimes the effect of disease primarily seated in this cavity.*

There is no doubt that a purulent condition of the fluids of this cavity is often complicated with ulceration of the lining membrane, but that the affection is different from abscess, its very nature and situation is sufficient to show. "A reference to the structure of the antrum," says Mr. Bell, "would appear to be sufficient to point out the improbability, to say the least, of the occurrence of abscess in such a situation. That a mucous membrane covering, in a thin layer, the whole internal surface of such a cavity, should become the seat of all the consecutive steps of true abscess, is a statement bearing on the face of it an obvious absurdity."† Notwithstanding the seeming improbability of such an occurrence, and it is certainly one that very rarely happens, abscess does sometimes develop itself in this cavity; but, it is a different affection altogether from that usually treated of under that name. We have already adverted to a case narrated by Mr. Bell, a description of which, we intend hereafter to give.

When complicated with ulceration of the mucous membrane—and it is probable that a purulent condition of its secretions, in most instances, is thus complicated—the affection is analogous to ozena, and many of the older writers designate it by that name. Mr. Bell describes it, and very properly too, as being similar to gonorrhœa; both diseases alike consist in an alteration of secretion; in the one case of the pituitary membrane, and in the other of the mucous lining of the urethra; but in neither instance does it possess any of the characteristics of abscess, though the matter in both is purulent.‡

It has been before stated that the obliteration of the nasal opening was more frequently an effect than a cause of disease in the maxillary sinus; it does, however, sometimes become closed from other causes than an unhealthy condition of this cavity; when this happens, engorgement of the sinus is the inevitable consequence. The fluids thus accumulated are not always at first purulent, although they may subsequently become so; when the closing of the opening is the result of previous disease in

* Memoires de l'Academie Royale Chirurg., vol. 12, p. 8.

† Anat. Physiol. and Diseases of the Teeth, p. 253. ‡ Ibid. p. 254.

the antrum, the secretions are more or less altered from the very first.

Accumulation of any secretion within the antrum, whether of mucus or pus, is a source of irritation to the lining membrane, and the pressure which it ultimately exerts upon the surrounding walls, causes a new form of diseased action, which not unfrequently involves in disease all the bones of the face as well as those of the base of the cranium. When prevented from escaping through the nasal opening, the secretion eventually makes for itself a way of escape—sometimes through the cheek; at other times beneath it, just above the alveolar ridge; or through the palatine arch or alveoli by the sides of the roots of one or more of the teeth; and from a fistula thus established, fetid matter will be almost constantly discharged. From openings of this sort the matter is sometimes discharged for years, while the disease in the antrum, very frequently, does not seem to undergo any apparent change. At other times the membrane ulcerates and the bony walls become carious.

A purulent secretion from the mucous membrane of this cavity, independently of caries of the bone, or even of simple fistulous openings, is an exceedingly troublesome and unpleasant affection. The odor from the matter is often very annoying even to the patient, and when the secretions are retained for some days in the sinus before they escape, the fetor is almost insufferable.

In good constitutions, the secretions of the antrum are not so liable to become purulent, though they be confined for a long time in the cavity, and thus become more or less offensive. Inflammation of the lining membrane (the immediate or proximate cause) may exist for years without giving rise to it. It is only in scrofulous, scorbutic, or debilitated habits that they are liable to become thus altered. The difference in the effects produced upon them and the surrounding parts, by inflammation, is owing to the differences in the state of the constitutional health of those affected with it.

Where a puriform state of the secretions is complicated with ulceration of the membrane, the matter will have mixed with it a greater or less quantity of flocculi, sometimes of so firm a consistence, as to block up the nasal opening and prevent its exit. Mr. Thomas Bell says, he has seen more than one case in

which a considerable accumulation had taken place in the antrum, accompanied by the usual indications of this affection, (muco-purulent engorgement of the sinus,) when a sudden discharge of the contents into the nose took place, "in consequence of the pressure having overcome the resistance which had thus been offered to its escape."* Cases of a very similar nature have fallen under our observation, the history of one of which will be given in the course of this chapter. The formation of these flocculi rarely ceases, except with the cure of the ulcers on the membrane. They give rise to considerable irritation, and their presence always constitutes an obstacle to the cure. They are usually easily removed by injections.

The pituitary membrane of the antrum, when in a healthy state, secretes, as we have before stated, a transparent, slightly viscid and inodorous fluid, poured out only in sufficient quantity to lubricate the cavity. But when inflammation is excited in the membrane, its secretions soon become more abundant, and are at first thinner, afterwards thicker and more glutinous. Their color and consistence are not always the same. Instead of being transparent, they sometimes have a dirty opaque appearance; at other times they assume a greenish, whitish or yellowish color, and in some instances they bear a considerable resemblance to pus, which, it has been conjectured, might be owing to suppuration of some of the mucous follicles and a mixture of pus with its secretions. Mr. Thomas Bell, however, inclines to the opinion that it is attributable to an "alteration simply" of the secretions of the cavity. Their color and consistence are determined by—the degree of inflammation; the length of time it has existed; the state of the health of the lining membrane, and that of the surrounding osseous walls; the egress which the matter has from the sinus; and the general habit of the body.

Affections of this sort are more common to young subjects than to middle-aged or persons in advanced life. An eminent French writer says, that of three individuals affected with dropsy (mucous engorgement), the oldest was not twenty years of age.

* Anat. Physiol. and Diseases of the Teeth, p. 258.

SYMPTOMS.

The diagnoses of the several affections of the antrum are so much alike, that it is often difficult to distinguish those that belong to one from those attendant upon another. The symptoms of mucous engorgement and purulent accumulation, however, are generally such as will enable the practitioner to distinguish, with considerable certainty, these from other affections. They are always preceded by inflammation of the lining membrane; a description of the symptoms of which, having already been given, need not be repeated. Omitting these, we at once proceed to mention those by which they are accompanied.

In speaking of the symptoms more particularly belonging to a purulent condition of the secretions of the antrum, Deschamps says, the affection may be distinguished by dull heavy pain, extending along the alveolar border. Upon this symptom alone, little reliance can be placed, as it is always present in chronic inflammation. In addition to this, he mentions—the presence of decayed teeth; soreness in those that are sound; and, on the patient's inclining his head to the side opposite the one affected, the discharge of fetid matter from the nose. These are very conclusive indications of purulent effusions in this cavity. Bordenave, after enumerating the symptoms indicative of inflammation, mentions the following as belonging to the affection of which we are now speaking,—dull and constant pain in the sinus, extending from the maxillary fossæ to the orbit; a discharge of fetid matter from the nose, when the patient inclines his head to the opposite side, or when the nose is blown from the nostril of the affected side.* These symptoms are mentioned by almost every writer upon the subject, as indicative of a purulent condition of the secretions of the maxillary sinus.

The symptoms of engorgement differ materially from those which denote simply a purulent condition of the mucous secretions. The pain, instead of being dull and heavy, as just described, becomes acute, and a distressing sense of fullness and weight is felt in the cheek, accompanied by redness and tume-

* Memoires de l'Academie Royale de Chirurgie, 12mo, tom. 12, p. 10.

faction of the integument covering the antrum.* The nasal opening having become closed, the fluids of the cavity gradually accumulate until they fill it; when, finding no egress, they press upon and distend the surrounding osseous walls, causing those parts which are the thinnest ultimately to give way. The effects are generally first observable anteriorly beneath the malar prominence, where a smooth hard tumor presents itself, covered with the mucous membrane of the mouth. But this is not always the point which first gives away, the sinus sometimes bursts into the orbit, at other times outwardly through the cheek, or through the palatine arch. The long continued pressure thus exerted upon the bony walls, often causes the breaking down or softening of their tissues.

The tumor, which is at first hard, becomes in a short time so soft as readily to yield to pressure. A distension, Deschamps says, may be distinguished from other diseases that affect the skin or subcutaneous tissues by—the uniformity or regularity of the tumor; its firmness at the commencement; the slowness with which it progresses; and, above all, by the natural appearance of the skin, and the absence of pain when pressure is made upon the tumor. Obliteration of the nasal opening, he says, may be suspected by the dryness of the nostril of the affected side, the mucous membrane of which becomes thickened, and the cavity contracted; inflammation and sponginess of the gums, loosening and sometimes, (in consequence of the destruction of their sockets,) displacement of the teeth, may also be mentioned as occasional accompaniments of engorgement.

CAUSES.

Inflammation of the mucous membrane is the cause of a purulent condition of the secretions of the maxillary sinus, and this arises more frequently from alveolo-dental irritation than from any particular habit of body or constitutional disturbance. Engorgement results from the obliteration of the nasal opening, which, in the case of altered secretion, is usually caused by inflammation and thickening of the lining membrane.

* Bell on the Teeth, p. 256, see also Maladies des Fosses Nasales, p. 228.

TREATMENT.

The curative indications of muco-purulent secretion and engorgement of the maxillary sinus are, 1st, if the nasal opening be closed, the evacuation of the retained matter; 2dly, the removal of all local and exciting causes of irritation; 3dly, and lastly, the restoration of the lining membrane to its normal function.

For the fulfillment of the first, an opening must be made into the antrum, and this should be effected in that part which will afford the most easy exit to the retained matter. Several ways have been proposed for the accomplishment of this object, and before we proceed further, it may not be amiss to notice some of the various methods that have been adopted by different practitioners.

Dr. Drake, an English anatomist, and author of a work entitled "*Anthropologia Nova*," has the credit of being the first to propose the perforation of the floor of the sinus through the alveolus of one of the roots of a molar tooth. This method, however, is said by some to have been inserted into Drake's Anatomy by Mr. Cowper, an eminent anatomist and surgeon.* M. Günz says the credit belongs to John Henry Meibomius, who, a long time before, proposed a very similar method of treating these affections.† Henry Meibomius, many years after the death of his father, John Henry, proposed for the evacuation of accumulated fluids in the antrum, the extraction of one of several teeth.‡ It is not all probable that Meibomius was the first to propose the perforation of the antrum in this way, for his researches were not published until 1718, twenty-one years after the publication of Drake's System of Anatomy, and, besides, he regarded the perforation of this cavity as a dangerous operation, and, on that account, confined himself simply to the extraction of a tooth. The perforation of this cavity through the alveolus of a superior molar is an operation which was performed by Swinger a long

* Heister's Surgery, note to chapter 72, p. 445.

† Mem. de l'Acad. Royale de Chirurg. 12mo, vol. xii, p. 12.

‡ Discurs. de Abscessibus Internis. Dresd., 1713, p. 114, and La Dissertation de Günz.

time before it was made by Meibomius, according to Velpeau; who also says that Saint Yves treated with successs a person affected with fistula, the floor of whose orbit had been destroyed by the removal of a tooth; and Vanuessen says Ruysch extracted several molars and cauterized their sockets, for the destruction of a polypus, until an opening was made into the antrum large enough to admit the finger; but we are also informed by Bordenave that Cowper treated a case of maxillary ozena, which had caused a large quantity of ichorous, fetid matter, to be discharged through the nose, by extracting the first molar, and perforating the antrum through the alveolus with an instrument suited to the purpose; Drake, according to the same author, seems to be entitled to the credit of having been the first to perforate the maxillary sinus as above described.

With regard to the tooth most proper to be extracted authors differ. Cheselden preferred the first or second molar, Junker recommends the extraction of the first or second bicuspid, and if a fistula had formed, to enlarge it instead of perforating the floor of the antrum. But the second molar, being directly beneath the most dependent part of the cavity, is the most suitable tooth to be removed. If this be sound, the first or third molar or either of the bicuspids, if carious, may be extracted in its stead, and in fact, no tooth beneath the antrum, in an unhealthy condition, should be permitted to remain.

An opening having been effected through the alveolus of a tooth into the antrum, it should be kept open until the health of the cavity is restored. For this purpose, sounds and bougies adapted to the purpose have been introduced. Heuerman recommends the employment of a small canula, which is also preferred by Bordenave and Ritchter, the latter of whom says, it should be kept closed to prevent particles of food from getting into the sinus. But whether a canula or bougie be introduced into the opening, it should be so secured as to prevent it from falling out or passing into the antrum. Deschamps recommends that it be fastened to one of the adjoining teeth by means of a silk or metallic ligature.

But the perforation of the maxillary sinus through the alveolus of a molar tooth, is said not to be the most ancient method. Molinetti, as early as the year 1675, describes an opening made

through the cheek into the antrum, the wall of which, after having been exposed by a crucial incision through the integuments covering it, was penetrated with a trephine.

Lamorier, an eminent surgeon of Montpellier, recommended perforating the antrum immediately above the first molar, or rather between it and the malar bone. In this, he seems to have been influenced by the consideration that the wall of the cavity here presents the least thickness, and that this is the most dependent part of the sinus. If a fistulous opening had previously formed in some other place in the mouth, he did not always deem it necessary to make another. His method of operating is as follows: The jaws being closed, the commissure of the lips are drawn outward and slightly upward with a curved speculum; this done, the gum is incised across the malar apophysis, or maxillo-labial sulcus, the bone made bare, and then pierced with a spear-pointed punch. The opening may afterwards be enlarged if found necessary.

Desault prefers that the opening should be made through the canine fossa, beneath the upper lip, and for that purpose, after having laid bare the bone, he employed a sharp triangular and blunt pointed perforator, which he invented for the operation. Runge, says Velpeau, used nothing but a scalpel. Mr. Charles Bell invented a trephine for the purpose, but this does not possess any advantage over the instruments employed by Desault and Runge. In case of fistula in the cheek from the antrum, Ruffel advises the insertion of a trocar, to be carried through the gum, so as to form a counter opening. Through this, in a case which he treated, he passed a seton, and it remained six weeks; at the expiration of this time, a cure was accomplished. This practice has been followed by Callisen, Zang, Busch, Henkle, Bertrandi, Faubert and others. Callisen states that when the tumor points in the palatine arch and fluctuation is felt, the artificial opening should be formed there. Gooch, in a case which he treated, advised the perforation of the antrum through the nasal surface, and fixing in the opening a canula of lead. We are also informed by the same author, that Acrel, after having operated in the manner proposed by Cowper, inserted a second canula into a sinus through a fistulous opening formed in the nose. The method attributed to Weinhold, consists in penetrat-

ing the sinus from the upper and external part of the canine fossa, with the instrument directed obliquely downward and outward, so as to avoid the branches of the infra-orbital nerve; and then placing a little lint in the opening thus made. Weinhold directs, that when the antrum has no other opening, the instrument should be carried entirely through the palatine arch, and then by means of a curved needle and thread, he introduces a roll of lint, saturated or covered with some appropriate medicine, and this, he designs to act as a seton.

Velpeau says, the perforation is effected "in the point of election or of necessity. The first varies according to the ideas of the operator: circumstances, on the contrary, determine the second. In cases of abscess, dropsy, fistula, and ulceration, the operation is almost always performed in the place of election. Provided one of the molar teeth be unsound, it must be ex tracted, together with the adjoining tooth; the gum is then to be cut down to the bone, externally, internally, behind and before, forming a kind of square flap, and to be completely detached from the surrounding tissues; after this the alveolus is to be perforated with the instruments of Desault, and an opening made large enough to admit the finger into the sinus." For the evacuation simply of purulent mucus, or accumulated fluids, we believe with Boyer, that the opening should always be made from beneath; and we are the more convinced of the importance of giving the alveolus of an extracted tooth the preference, from the consideration that it is to the irritation produced by some one or more of these organs, that the diseases of this cavity are attributable. Even though a fistula may have formed above the alveolar ridge, beneath the cheek, or in the palatine arch, we should not neglect to extract such teeth, whether carious or sound, as may be productive of irritation. It may not always in such cases be necessary to perforate the sinus from the socket of a tooth, though the cure, in most instances, is expedited by it.

Jourdain, an eminent French dentist and graduate in surgery, instead of seeking egress for matter accumulated in the maxillary sinus by any of these methods, proposed, in a memoir presented to the Academy in 1765, to probe the cavity by its natural opening, and then, by suitable injections, to restore it to health. The Academy gave this proposition a careful attention,

and thoroughly discussed it. The practicability of obtaining entrance into the sinus in this way was called in question, and it was contended that the difficulties presented by the peculiar structure of the parts were such that they would seldom be overcome. The practice has been wholly abandoned.

When the natural opening is closed, the first indication, as has been stated, is the evacuation of the matter; and for this purpose, a perforation should be made into the sinus, and the most proper place for effecting this, it has been shown, is through the alveolar cavity of the second molar. It may, however, be penetrated from that of either of the other molars or bicuspids.

The perforation, after the extraction of the tooth, is made with a straight trocar, which will be found more convenient than those usually employed for the purpose. The point of the instrument, having been introduced into the alveolus through which it is intended to make the opening, should be pressed against the bottom of the cavity in the direction toward the centre of the antrum. A few rotary motions of the instrument will suffice to pierce the intervening plate of bone.* If the first opening be not sufficiently large, its dimensions may be increased to the necessary size by means of a spear-pointed instrument. The entrance is usually attended with a momentary severe pain, and the withdrawal of the instrument followed by a sudden gush of fetid mucus. In introducing the trocar, care should be taken to prevent a too sudden entrance of the instrument into the cavity. Without this precaution, it might be suddenly forced against the opposite wall. It is not always necessary to perforate the floor of the antrum after the extraction of the tooth; it occasionally happens, as has already been remarked, that some of the alveolar cavities communicate with it.

An opening having thus been effected, it should be prevented from closing until a healthy action is established in the lining membrane, and for this purpose, a bougie, or leaden or silver canula, may be inserted into the opening and secured to one of the adjacent teeth. It should, however, be removed for the evacuation of the secretions at least twice a day. The forma-

* In a collection of nearly one hundred superior maxillæ, presented to the Museum of the Baltimore Dental College, by Dr. Maynard, the floor of the antrum varies in thickness, from that of tissue paper to half an inch.

tion of an opening at the base or most dependent part of the sinus will, in those cases where a fistula has been previously formed, be followed, in most instances, by its speedy restoration. Having proceeded thus far, the cure will be aided by the employment of such general remedies as may be indicated by the state of the general health; and for the dispersion of the local inflammation, leeches to the gums and cheek will be found serviceable. The antrum may, in the meantime, be injected with, at first, some mild or bland fluid, and afterward with gently stimulating liquids. Dilute port wine, a weak solution of the sulphate of zinc and rose water, and also that of copper and rose water, have been recommended. Diluted tincture of myrrh may sometimes be advantageously employed, and when the membrane is ulcerated, a solution of nitrate of silver will be highly serviceable. The author has used a solution of iodide of potassium with advantage; also a weak alcoholic solution of tannic acid. For correcting the fetor of the secretions, a weak solution of the chlorinated soda or lime may be occasionally injected into the antrum.

In cases of simple muco-purulent secretion, a weak decoction of galls may be injected into the sinus with advantage. Injections of a too stimulating nature are sometimes employed. This should be carefully guarded against, by making them at first weak, and afterwards increasing their strength as occasion may require; and if symptoms of a violent character are by this means produced, they should be combated by applying leeches to the gums and fomentations to the cheek.

Dependent as these affections in most instances are, upon local irritants, greater reliance is to be placed on their removal and giving vent to the acrid puriform fluids, than on any therapeutical effects exerted upon the cavity by injections. As adjuvants, they are serviceable, but a cure cannot be effected while the exciting cause remains unremoved.

The following cases may serve to illustrate the treatment usually pursued in this disease.

Case 1st. Mrs. T., a married lady, about forty years of age, of a bilious temperament, applied to the author for advice, in 1853. She had suffered from neuralgic pains in her face and temples, at intervals, for nearly twenty years, and as all of her

teeth, especially of the upper jaw, were so much decayed as to preclude the possibility of restoration, he urged their immediate removal. She submitted to the operation, hoping that it would relieve her from the pain to which she had so long been a martyr, and intending to have the lost organs replaced with an artificial set. She called again in a few months, partly for this purpose and partly to obtain relief from pain which she still experienced. It was not now so much diffused as formerly, but was almost wholly confined to the left side of the face. On inquiry, it was ascertained that fetid matter was occasionally discharged from the nostril of the affected side. This led him to suspect that the antrum was diseased. An opening was accordingly made through the alveolar border, at the point originally occupied by the second molar. The withdrawal of the instrument was followed by the discharge of a small quantity of purulent matter. The antrum was now forcibly injected with water. This caused the discharge of more than two table-spoonfuls of hardened flocculi from the left nostril, which from long confinement, were insufferably offensive. The injection was repeated until the antrum was completely freed from this accumulation. A solution of sulphate of zinc, in the proportion of six grains to the ounce of water, was now substituted. The sinus was injected daily with this for a little more than a week, and without any other treatment a complete cure was effected.

The particulars of the following case are obtained from "Observations of Bordenave on the Diseases of the Maxillary Sinus,"* a paper embodying reports of forty highly interesting cases.

Case 2d. "In 1756," says our author, "I was consulted by a lady whose right cheek was tumefied. About a month previously she had experienced acute pain under the orbit of the affected side; and she had felt a pulsation and heat in the interior of the sinus, and the maxillary bone was slightly elevated. These signs determined me to propose the extraction of the first molar tooth and the perforation of the antrum through the alveolus. The operation was followed by a discharge of purulent matter, the sinus was afterwards injected, the maxilla gradually reduced itself, and a cure was effected in about two months."

* Mem. de l'Acad. Royale de Chirurg., vol. xii, obs. 3, p. 10.

Although injections were employed in the above case, it was no doubt the escape of the matter contained in the antrum to which the cure was attributable. As regards the cause that gave rise to the affection in the first instance, not a single word is said. It may have resulted from inflammation, lighted up in the sockets of one or more teeth, and progagated from thence to the mucous membrane of this cavity, or from inflammation produced by some other cause, and a consequent obliteration of the nasal opening.

The following brief statement is taken from the history of a case narrated by Fauchard.*

Case 3d. The child of M. Galois, æt. twelve years, whose first right superior molar was decayed, had a tumor situated anteriorly upon the upper jaw of the same side, extending up to the orbit. M. Fauchard, supposing this tumor, which was about the size of a small egg, had been caused by the carious tooth in question, determined on its extraction as the only means of effecting a speedy and certain cure, and the result proved his opinion correct. The removal of the tooth was followed by a large quantity of yellow serous matter, which, on examination, was found to have escaped from the antrum. The tumor disappeared soon after the discharge of the matter, and a complete cure was effected.

Bordenave, in noticing the foregoing case, does not believe that the tumor communicated with the maxillary sinus, for the reason that the matter escaped through the alveolus of the first molar immediately after its extraction. He, however, admits that the acumen and knowledge of Fauchard are such as to have prevented deception in the case. Admitting, then, the statement to be correct—and surely the circumstance mentioned by Bordenave does not in the least tend to invalidate it, for it is of frequent occurrence—a cure was effected simply by the removal of a decayed tooth, to the irritation produced by which the disease was undeniably attributable. The two following cases are described at length by the last named author in the "Memoires de l'Academie Royale de Chirurgie."†

Case 4th. A woman, in 1731, had the first superior molar,

* Le Chirurgien Dentiste, tom. i, obs. 8, p. 483.

† Vol. xii, 12mo, Observations 5 and 6, pp. 12 and 19.

the crown of which had been destroyed by caries, extracted. Not many days after the operation, she was attacked with pain in the upper jaw, which extended from the maxillary fossa to the orbit. The pain was so great as to deprive her of rest, but there was no tumefaction of the cheek or gums. An opening through the alveolus into the sinus was discovered, into which a probe was introduced by a surgeon. The withdrawal of this was followed by a discharge of yellow fetid matter. M. Lamourier, who was afterwards consulted, removed from the opening a tooth that had been thrust into the antrum and prevented the egress of the matter, which, by its retention, had become purulent. Injections were employed, a part of which, at the expiration of thirty days, escaped from the nasal opening. A perfect cure was soon after effected.

In this case, the affection of the sinus was evidently the result of the injury inflicted upon the socket of the first superior molar, in an attempt at the extraction of the tooth. The inflammation excited by this, and by the presence of the tooth that had been thrust into the antrum, extended itself to the lining membrane of this cavity, and caused a temporary obliteration of the nasal opening, so that to effect a cure it was necessary to obtain free vent for the retained matter. In restoring to a healthy action the mucous membrane of the cavity, the injections may have been serviceable.

Case 5th. A girl, æt. twenty-six years, had a very much decayed and painful superior dens sapientiæ on the right side extracted; the tooth was broken, and all the roots but one were left in their sockets. These caused an abscess to form, and this was followed, for a short time, by a subsidence of the pain; which, however, soon returned, and a dull, heavy sensation was felt in the antrum of the affected side. From thence the pain extended to the eye and ear. The gums at length became tumefied, and the pain less constant; the patient remained in this condition for five years, during which time five teeth were extracted. At this time (1756), M. Beaupreau, who was consulted, found, on examination, that the gums where the first tooth had been extracted had not entirely united, and a small tubercle had formed, from which a fluid of a bad smell and reddish color was discharging itself. He introduced a probe into the fistulous hole

of the tubercle, which, after having overcome some obstacle that at first impeded its passage, penetrated the antrum. The opening was enlarged and mercurial water applied to the carious bone; but it soon closed, and the pain, which had ceased, returned. Injections then were resorted to, which discharged themselves in part through the nasal opening, and the patient continued in this way until an exfoliation of the bone took place, when a cure was effected.

The cause of the disease in this, as in the preceding cases, was alveolo-dental irritation, and a cure would at once have been accomplished by the removal of the roots of the tooth that had been left in their sockets; this was proven by the fact that it was not until they were thrown off with their exfoliated alveoli, that the disease was subdued.

In alluding to these and similar cases, Bordenave concludes there are not many cases where the extraction of teeth simply, will suffice to effect a cure. This inference, to say the least of it, is unfair; for in the case last given, the disease was attributable to the presence of the roots of a tooth that had been fractured in an attempt to extract it, and left in their sockets, and we have good reason to believe that the cure was wholly owing to their removal.

The history of the following exceedingly interesting case, which was communicated to the Faculty of Medicine by Professor Dubois, is contained in the eighth number of their bulletin for the year 1813, and also in Boyer's work on Surgical Diseases.

Case 6th. Upon a child between seven and eight years old, at the base of the ascending apophysis of the superior maxillary bone, a small hard round tumor of the size of a walnut was perceived by its parents. About a year after, the child fell upon its face, and caused a considerable discharge of matter from its nose, at the same time bruising the tumor. No other injury was received, and the tumor did not increase perceptibly in size from the eighth to the fifteenth year. During the next year, however, it sensibly augmented, and from the sixteenth to the eighteenth year, it attained so great a volume, that the floor of the orbit was elevated, which caused a diminution in the size of the eye, and restricted the motions of the eyelids. The arch of

the palate was depressed, and the nasal fossa almost closed. The nose was forced to the right side of the upper part of the tumor, and there was a considerable elevation beneath the sub-orbital fossa. The skin below the inferior eyelid was of a violet red color, and very tense. The upper lip was elevated, and the gums on the left tide protruded beyond those on the other side of the arch. Respiration was painful, and the patient spoke with difficulty. Sleep was laborious, and mastication was attended with pain. "In this state," says M. Boyer, "he was seen by M. Dubois, September 1st, 1802; but as he was not able to determine on the proper operation, M. Sabatier, M. Peletan and himself were called in. It was the opinion of all, that there was a fungous tumor of the antrum, and for the removal of this, M. Dubois was requested to make choice of his own method of operating.

A fluctuation was felt behind the upper lip, and this determined M. Dubois to commence the operation by making an incision there, which was followed by the discharge of a large quantity of a glairy, lymphatic substance. Through this opening a sound was introduced into the antrum, and to M. Dubois' surprise, this cavity contained no tumor; but upon moving the sound about, it struck upon a hard substance, in the most elevated part of the sinus, which, on being removed, proved to be a canine tooth. Preparatory, however, to its extraction, two incisors and one molar were removed and their alveoli cut away. Injections were afterwards employed, and the patient was soon restored to health.

It is not necessary to stop to inquire how this tooth got into the antrum; aberrations of this sort in the growth of the teeth are frequently met with, and some precisely similar instances have already been referred to.*

In all the cases which have as yet been noticed, the affection was traceable to local irritation, and in all, except the last, it originated in the alveolar ridge. The following case of muco-purulent engorgement may be thought by some to have been occasioned by a different cause. Yet, there are circumstances connected with the history of even this case, that go to justify the belief, that if the teeth had been in a healthy condition the affection would not have existed.

* Mem. de l'Academie de Chirurg., vol. v, Mem. 257.

Case 7th. Mr. G——, a laborer, about thirty years old, of a decidedly scorbutic habit, applied in the spring of 1834, to an eminent physician of Baltimore, to obtain his advice concerning an affection of the left side of his face, under which he had been laboring for several months. The physician after having examined the case, came to the conclusion, that it was mucous engorgement of the maxillary sinus, and requested him to call upon us, and have one of his molar teeth extracted, and the floor of the antrum pierced through its alveolus. He at the same time desired, that if his opinion in regard to the nature of the disease proved to be correct, we should take charge of the case altogether. On examining his mouth, we discovered that nearly all the teeth of both jaws, the gums and alveoli, were extensively diseased, and, on inquiry, obtained from him the following statement with regard to the commencement and progress of the affection.

About six months before this time, having been exposed, while pursuing his ordinary avocations, to very inclement and changeable weather, he contracted a severe cold; in consequence of this he was confined to his bed for several days, during which time, he was twice bled, took two cathartics, and other medicines.

The disease at first settled in his head, face, and jaws, but at the expiration of eight or ten days, was subdued by the above treatment, with the exception of the pain in his left cheek, and soreness in the upper teeth of the same side. The pain in his cheek, although not constant, still continued; the nasal cavity of that side ceased to be supplied with its usual secretion, the teeth became more sensitive to the touch; finally, at the end of four months, a slight protuberance of the cheek was observable, accompanied by a tumor upon the left side of the palatine arch, which, when we first saw him, had attained to half the size of a black walnut; and it was by the fluctuation felt here, that the physician whom he first consulted, was induced to suspect the true nature of the disease.

Acting in consultation with the medical gentleman in whose care the patient had placed himself, we extracted the second left superior molar; then through its alveolus penetrated the antrum by means of a straight trocar, after the withdrawal of which, a

large quantity of glairy, fetid mucous fluid was discharged. The perforation was kept open by means of a bougie, secured with a silk ligature to an adjoining tooth, as recommended by Deschamps, and the antrum injected three times a day, at first simply with rose water, to which a small quantity of sulphate of zinc was afterwards added. By this treatment, the lining membrane of the antrum, at the expiration of five weeks, was restored to health, and the secretions that escaped through the perforation, no longer exhaled a fetid odor.

The patient, not experiencing any inconvenience, withdrew the bougie, and allowed the aperture to close. In about two months, he again presented himself to the author similarly affected as when he first saw him. He now extracted the first superior left molar, and perforated the antrum through the alveolus, and a quantity of fetid mucous fluid was again discharged; the dens sapientiæ, and the first and second bicuspids of the affected side, being carious, were also extracted. Injections of sulphate of zinc and rose water, diluted tincture of myrrh, diluted port wine, and a decoction of nut galls, were alternately employed for three months; at the expiration of this time, the nasal opening, which had been previously closed, was re-established, and a perfect cure effected.

The condition of the teeth in the case just narrated, may not be thought to have exerted any agency in the production of the affection of the antrum, but the following considerations would seem to justify a different conclusion. The presence of decayed teeth beneath the sinus, may not only have contributed to aggravate the morbid action lighted up by the cold which he had taken, but may also have caused it to locate itself in this cavity; and the fact that the inflammation of the lining membrane and the obliteration of the nasal opening continued until they were removed, would, at least, seem to warrant such an inference. That the injections were beneficial, we do not doubt, but that the cure was effected by them, no one, we think, will dare to affirm. We are far from believing that the presence of the decayed teeth was the sole cause of the disease of the antrum; that they contributed to, and protracted it, we cannot hesitate to believe; still, but for the increased excitability, and, perhaps, actual inflammation, induced in the mucous membrane, by the exposure of the

patient to inclement and sudden transitions of weather, it is probable the sinus would never have become affected. But on the other hand we think it not unlikely that, although the disturbance may have been originated from this cause, no very serious or lasting morbid effect would have been produced, if the teeth and alveoli had been in a perfectly healthy condition.

The particulars of the following highly interesting case were communicated to the author by Dr. L. Roper, of Philadelphia, in a conversation which he had with him in 1845.

CASE 8th. Miss M——, a young lady from the West Indies, about fourteen years of age, had a fistulous opening beneath the right orbit, communicating with the maxillary sinus. By means of a probe introduced through the opening into this cavity, the apices of the roots of the first superior molar could be distinctly felt.

Medical aid was sought at an early stage of the disease, but as no permanent benefit resulted from the treatment adopted, the young lady, at the expiration of nine months, was brought by her father to Philadelphia, and in the spring of 1831, placed under the care of the late Dr. Physick. He suspecting that the affection of the antrum had resulted from and was still kept up by irritation, produced by the first superior molar of the affected side which was considerably decayed, directed her to be taken to Dr. Roper, who, concurring with him in opinion, at once extracted the carious tooth. The operation was followed by the immediate discharge of a large quantity of thick, muddy, and greenish matter. The fistula under the orbit soon closed, and without further treatment, a perfect cure was accomplished in the course of a few weeks.

The foregoing are all the particulars which we could obtain concerning this interesting case. We have no doubt that if all the circumstances connected with its early history were known, it would be found to have resulted from inflammation of the lining membrane of the antrum, caused by irritation in the socket of the tooth which was extracted. This opinion is sustained by the facts, that this tooth was affected with caries, and that its removal was followed by the immediate cure of the disease.

In Bordenave's collection of cases of disease of the maxillary sinus, published in the Memoirs of the Royal Academy of Sur-

gery, there are several examples similar to the one just narrated. We subjoin a description of the two following:

CASE 9th. A servant of the Count de Maurepas had been afflicted for six months with a fistula upon the left cheek, a little below the orbit, penetrating to the maxillary sinus, and caused by the spontaneous opening of an abscess. The first and second molars, both of which were considerably decayed, were extracted by M. Hevin. As there were no openings through the alveoli, he perforated one with a trocar; this opening gave vent to a great quantity of putrid sanies, and did not close for more than a year after it was made. The fistula of the cheek healed in about ten days.

CASE 10th. In 1717, a soldier of the regiment of Bassigny, who had for a long time a fistula in his cheek penetrating into the maxillary sinus, was treated for it at the Hotel Dieu, of Montpelier. The matter settling near the orifice of the fistula, prevented it from closing. M. Lamourier, on examining the mouth of the soldier, perceived that the second superior molar was decayed; this he extracted and profited by the alveolar cavity to make an opening into the base of the sinus. The fistula of the cheek was by this means cured in a few days, but the counter opening was not immediately permitted to close.

In cases of fistula resulting simply from engorgement of the sinus, the treatment should consist, as in the foregoing cases, in the formation of a counter opening, which should always be effected at the most dependent part of the cavity; and next in the removal of all sources of local irritation; lastly in the employment of suitable injections.

In the cases thus far presented, we have selected such as were not complicated with abscess, ulceration of the lining membrane, or caries of the surrounding osseous walls; but to the existence of the two last, the affections of which we have been treating often give rise. Without extending our remarks further upon mucous engorgement and purulent conditions of the secretions of this cavity, the next form of disease on which we propose to speak, is abscess—an affection, differing in all its characteristics from any of the foregoing.

CHAPTER FOURTH.

ABSCESS OF THE MAXILLARY SINUS.

The formation of abscess in any other part of the maxillary sinus than at the extremity of the root of a tooth which has penetrated the cavity, is exceedingly rare. There are on record but two well authenticated cases in which it has happened, so far as we have been able to ascertain. One of these is described by Mr. Thomas Bell,* and the other by Bordenave.† The abscess in both instances was seated in the upper part of the antrum, beneath the orbit. But as we shall have occasion to refer to these cases again, it is not necessary to say more concerning them at this time.

Dr. Hullihen, in an article in the second volume of the American Journal of Dental Science, contends that antral, as well as alveolar abscess consists in the effusion of pus, formed in the pulp-cavity of a tooth, between the bone and lining membrane. That this view of the subject is incorrect, is proven by the fact, that abscess is almost as frequently formed in the sockets of dead as of living teeth. The matter from alveolar abscess, in those cases where the plate of bone intervening between the extremity of the root of a superior molar or bicuspid, is thinner than the surrounding osseous wall, often escapes through it into this cavity, after having first, as Dr. Hullihen justly remarks, effused itself between the bone and lining membrane. In this case, it cannot properly be termed an abscess of the antrum. Although the matter escapes into this cavity, and, in consequence, becomes involved in disease; yet the disease having originated in the alveolus of a tooth, which is still its principal seat, is, in the strictest sense of the term, alveolar abscess. It sometimes happens that pus from an abscess, formed in the socket of a superior molar, discharges itself into this cavity, and escapes through the open-

* Anatomy, Physiology and Diseases of the Teeth.

† Mem. de l'Acad. Royale de Chirurg., vol. 12, 12mo. ed, obs. xi. p. 31.

ing into the nose. A pulp may suppurate, and the matter be confined in the cavity of the tooth for a long time; or be discharged through a decayed opening in the crown, communicating with the internal cavity, without causing alveolar abscess. The purulent matter contained in the sac at the extremity of the root of a tooth, is not always formed, as Dr. Hullihen supposes, in the cavity of the tooth. The quantity of pus discharged from an alveolar abscess is often greater than that which could be formed by the suppuration of the soft tissues contained within the cavity of a tooth; and, besides, after this matter has been discharged, it cannot again be reproduced here; consequently, any matter which may afterwards accumulate in the cavity of the tooth, must be secreted by the soft parts about the extremity of the root. Again, abscess often forms at the extremity of the root of a tooth, after their internal cavities have been filled to the very apex. The alveolo-dental membrane at the apex of the root of a tooth, around the nerve cord, is more vascular, and endowed with greater nervous sensibility, than at any other part, consequently, the inflammatory action here is always greatest, and it is here that suppuration first takes place.

The apices of the roots of the first and second superior molars, when they do not actually perforate the floor of the antrum, are often above its level, and covered by only a very thin shell or cap of bone; hence, although abscess in one of the teeth is strictly alveolar, the matter is more liable to make for itself a passage into this cavity, than through the gum into the mouth. When this happens, it gives rise to inflammation of the lining membrane, causing its secretions to become more or less vitiated, and often leads to an erroneous opinion concerning the true seat of the disease.

It is only when the root of a tooth actually penetrates the floor of the antrum, or its apex is actually situated in it, that the disease can properly be said to be abscess of the antrum. When the root does penetrate it, the tubercle at its apex around the nerve cord and blood vessels, is between the lining membrane and periosteal tissue; both of which, in the immediate vicinity, become directly involved in inflammation, and this sometimes extends to every part of the cavity, causing, in some instances, obliteration of the nasal opening. This, however, does not often occur, but when

it does, is followed by engorgement of the sinus, occasionally, by ulceration of the lining membrane and disease in the surrounding parts.

Sometimes the plate of bone intervening between the extremity of the root of a tooth around which a tubercle has formed, and the antrum, is destroyed, and the tubercle, instead of being wholly confined within the alveolus, is forced up, as it enlarges, almost entirely into this cavity. The inflammation, after having attained a certain height, is succeeded by suppuration, and the secretion of pus goes on until the sac bursts, when the matter is discharged, and, mixing with the mucous secretions of this cavity, ultimately escapes with them through the nasal opening into the nose.

As regards the morbid effects produced upon the lining membrane and surrounding bony parietes of the antrum, by an abscess of this kind, if the matter be discharged there, it is of little consequence whether it be formed in the cavity, or in the alveolus of the tooth that gave rise to it. The effects are nearly the same in one case as in the other. If the general health of the patient be good, and the natural opening of the sinus remain pervious, the symptoms seldom assume an alarming character; but under other and less favorable circumstances, the most dangerous and aggravated forms of disease may result from abscess in either place.

SYMPTOMS.

In the incipient or formative stages of abscess of the maxillary sinus, the symptoms are similar to those that characterize inflammation of the lining membrane, or violent inflammatory tooth-ache. The pain is generally most severe in the upper part of the alveolar ridge, above one of the molar or bicuspid teeth. From thence, it often extends to the lower part of the orbit, the ear, temple, muscles of the cheek and scalp. It is more or less constant, and a throbbing sensation is felt high up in the alveolar border beneath the cheek. If the abscess is seated at the apex of the root of a tooth, this organ will appear slightly elongated and sore to the touch; the cheek, in most instances, is slightly tumefied, and more or less flushed. If the abscess is seated in

any other part than the base of the antrum, the symptoms may differ in some respects from the foregoing.

The pain, after having continued for several days, is succeeded by suppuration, when it immediately subsides. Slight paroxysms of heat and cold are now felt, and if the natural opening of the antrum is not closed, purulent matter will, occasionally, be discharged. If purulent matter, or mucus mixed with pus, be discharged from the nostril of the affected side, when the patient inclines his head to the opposite side, or makes a sudden and forcible expiration through it while the other is closed, the existence of abscess in this cavity will be very conclusively indicated.

The abscess having burst, pus will be discharged from time to time, for several days, which will escape through the nasal opening, with hardened flocculi or other matter, and will then very nearly or altogether cease. The disease, however, if the irritant which gave rise to it still remains, is by no means cured. A recurrence is liable to take place every time the patient takes cold, when all the symptoms just described will be again experienced; and each succeeding attack leaves the parts implicated in the disease in a more unhealthy condition, and, as a consequence, more susceptible to the action of morbid irritants. Suppuration, also, at each successive attack, takes place, and the pus gradually assumes a more and more unhealthy character.

CAUSES.

It will not be necessary to say much concerning the causes of abscess of the antrum. It is sufficient to state, they are the same as those of tooth-ache; namely, inflammation of the alveolo-dental periosteum or inflammation of the lining membrane of this cavity; to the presence of one or other, or both of these it is attributable. These may be occasioned by caries of the teeth, or a dead or loose tooth; or by a blow upon the cheek, or exposure to sudden changes of weather. Other causes may sometimes be concerned, but the foregoing are the principal, and all it is necessary to enumerate.

TREATMENT.

In the treatment of abscess of the maxillary sinus, as well as that of a muco-purulent condition of its secretions or engorgement, the first and most important indication is to obtain vent for the matter at the lowest part of the cavity. The best method of doing this has been described, and it is unnecessary to recapitulate the directions already given for the accomplishment of this object.

The formation of abscess might, however, in almost every instance be prevented by the timely adoption of proper treatment. On the occurrence of severe, deep-seated and throbbing pain in the upper part of the alveolar ridge, (or just above it in the region of the antrum, such as has been described as attending the formation of abscess in this cavity, or in the alveolus of a superior molar,) if the tooth directly beneath the place where it was first felt, be considerably decayed, or its lining membrane exposed, or if it be dead, loose, or the socket much diseased, it should be immediately extracted. By this simple operation, the formation of abscess not only in the socket, but also in the antrum, may, in almost every instance, be prevented.

The curative indications, if the abscess is of recent formation, and has resulted from the presence of a diseased tooth, are similar to the preventive. The first thing to be done is to remove the tooth that caused it, and if this operation is not delayed too long, it, in most instances, will be all that is necessary to effect a cure. In addition to this, Dr. Hullihen recommends the perforation of the antrum;* but in those cases where the abscess has formed at the apex of the root of a molar, this is not necessary; because in all such cases, the alveolus communicates with this cavity, so that on the removal of the tooth, there will be a sufficiently large opening communicating with it; besides the tubercle or sac, although situated within the sinus, is usually brought away with the tooth.

When the abscess has been of long standing, and the lining membrane of the antrum has become seriously affected, in addi-

* American Journal of Dental Science, vol. ii, p. 182.

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tion to the removal of the tooth, other treatment will have to be resorted to. The opening into the antrum, if necessary, should be enlarged, and it should be prevented from closing until the health of the lining membrane is restored. For the promotion of this, injections, such as have been already recommended, will be found serviceable.

In cases of simple abscess of the antrum, seated at the apex of the root of a superior molar, we have never found it necessary to adopt any other treatment than the foregoing. It may, however, in some instances, be necessary to remove more than one tooth.

We might, if it were necessary, give the history of several interesting cases of abscess of this cavity, originating at the extremity of the roots of teeth; but as the treatment is so simple, it would unnecessarily enlarge this portion of our work. But before we conclude our remarks upon abscess of this cavity, we will give the history of one case to which allusion has before been made. The following detailed statement we quote from Mr. Bell's treatise on the teeth.

Case 11th. "Mary B., aged eighteen, with an unhealthy and somewhat strumous aspect, of languid disposition, and of retiring and timid habits, came under my care on the 3d of January, 1817, in consequence of a severe and continued pain on the left side of the face, of a dull, heavy character, and apparently deep-seated, but occasionally darting in acute paroxysms across the face toward the nose. The cheek was swollen, and the palate somewhat enlarged. About a year before, the first superior molar of that side had been extracted, on account of severe pain in the face, but without producing any relief; the pain was, consequently, attributed to rheumatism, from which complaint she had long suffered to a great degree in the shoulder, hip and other joints, and for which she had been under the care of many medical practitioners, both in London and Bath, having been sent to the latter place for the use of the waters. When I first saw her, the general health was much deranged: the stomach, bowels and liver performed their functions very imperfectly; and the uterus partook of the general sluggishness of the system, menstruation being almost wholly suppressed, and the periods only indicated by increased indisposition, and especially by an exacerbation of the pain in the face.

"No discharge had taken place from the nose, but, from the nature and situation of the pain, the direction of its paroxysms, the enlargement of the cheek and palate, and from an occasional trifling discharge of pus from the alveolus of the tooth which had been extracted, I could not doubt that the antrum was the seat of the disease. On examining the teeth, I found that the second bicuspid was also diseased, and as it had at times occasioned considerable pain, I extracted it, with the view of removing every possible source of irritation.

"Six leeches were ordered to be applied to the face, and afterwards the continued application of a cold lotion. Medicines were also administered with reference to the general health, as regarded both the digestive and the uterine functions; and on January 7th I determined on puncturing the antrum. I consequently introduced the trocar through the anterior alveolar cavity of the first molar, and found that when the instrument came in contact with the lining membrane, the most acute pain was produced, indicating the existence of a high degree of inflammation in that structure. On withdrawing the trocar, when the antrum was freely opened, I was surprised and a little disappointed at finding that not the smallest discharge made its appearance. There was a small quantity of glairy mucus, but nothing more. I introduced the blunt end of a probe, and found that the opening was quite free; but on passing it upward toward the orbit, its passage was restricted by a firm elastic substance, which gave the impression that a solid tumor existed in the upper part of this cavity, and which produced intolerable pain on being pressed with the probe. I now injected some tepid water, and found that the nasal opening was pervious, as the water passed freely into the nose. As the operation had produced a considerable increase of pain, and as the parts appeared a good deal inflamed, I ordered six leeches to be applied, the bowels to be freely opened, and an opiate to be taken at night.

"January 9th. The pain had been extremely severe ever since the operation, with scarcely any mitigation, excepting for a few hours after the application of the leeches. A probe, now introduced into the antrum, met with similar resistance, but much nearer the orifice than before, proving that the tumor

had increased; and on injecting warm water, it no longer passed into the nose. The leeches, the aperient and the opiate were repeated.

"January 11th. The pain continued without cessation, and no sleep was produced by the opium. The inflammation apparently not reduced; pulse one hundred, small and feeble; the palate a little enlarged, but not more so than might be accounted for, by the thickening of the integuments from inflammation. I could now distinctly feel with a probe that the tumor was not only increased in size, but that it had become softer, yielding in some measure to pressure, and conveying the impression that it contained fluid. I therefore introduced a sharp pointed instrument, which with a little force pierced the tumor, and a gush of pus instantly took place, with immediate relief to the patient.

"Here, then, was a sac containing pus, existing doubtless as a distinct cyst, the result of inflammation in the membrane; for it is scarcely probable that the membrane itself had become separated from its attachment by the formation of pus between it and the bone. That the former was the true situation of the disease, may be inferred from the fact that no subsequent caries of the bone took place, which would, undoubtedly, have been the case, had the matter been formed in contact with the bone; and it could scarcely have been produced between the mucous membrane and the periosteum, as these two structures, though essentially distinct from each other, are inseparably connected.

"The pus continued to be discharged for a day or two, and then entirely ceased. In passing the probe, a week after the former operation, I found the same resistance as before, and in the same situation; the cyst was again punctured, and again the pus was discharged. This alternation of repletion and evacuation of the cyst regularly recurred for a considerable time, but the opening into the nose did not again become stopped. The general health, however, in the meanwhile, improved, and the pain in the face was greatly diminished, returning only, with any degree of violence, when the cyst was full.

"At length the repeated perforation of the sac, followed by the use of strong astringent injections, and aided by the remedies that were directed to the state of the general health, restored the antrum to a healthy condition; the menstrual dis-

turbance was by degrees entirely cured, and the stomach at the same time assumed its healthy function; but it was two years from the time I first saw her before she had recovered her health, which at the best was never robust."

There is a case described by Bordenave, which, in many respects, is similar to the foregoing; but having adopted a different treatment, the cure was more tardy, although ultimately effected. For the particulars of the case, the reader is referred to a Dissertation by the author on the Diseases of the Maxillary Sinus, page 86.

Finally, that abscess does occasionally form in other parts of the antrum than the base, is conclusively proven by the cases described by Bell and Bordenave. It is true, these are the only ones of which we have any account, nevertheless, they establish the fact that it is possible for them to occur in any part of this cavity.

CHAPTER FIFTH.

ULCERATION OF THE LINING MEMBRANE OF THE MAXILLARY SINUS.

This is not an idiopathic affection. It is always, we believe, symptomatic of some other morbid condition of the mucous membrane of this cavity, and often gives rise to some of the worst and most aggravated forms of disease to which it is liable. It is not a simple disease, but is complicated with the one that caused it, or with some other to which it has given rise. We shall treat of it, however, as a separate affection. Its attacks are preceded by a purulent condition of the fluids of the antrum, and are often followed by fungus, and sometimes by caries of the surrounding osseous walls. The membrane covering the floor of the cavity is usually first attacked; ulcers having formed here, they soon extend to other parts of the sinus.

Ulcers of this cavity present as great a variety of character as do those of other parts of the body. Their nature is determined by the state of the constitutional health and the causes that produce them. Without going into a minute description of the various kinds of ulcers, it will be sufficient to state that the following varieties have been met with: namely, the simple, or those resulting from mechanical injury; the fungous, scorbutic, venereal, cancerous, gangrenous, scrofulous; the inveterate, indolent, phagedenic, &c.

In the simpler species of ulcer, the discharge is of a thick consistence and nearly white; but as the disease assumes a malignant type, it becomes thinner and varies in appearance from a transparent to a dirty brown, yellow or black.

SYMPTOMS.

Many of the symptoms attendant upon ulceration of the mucous membrane of the maxillary sinus, are similar to those

that accompany other affections of this cavity; as, for example, deep seated heavy pain in the cheek, occasional escape of matter into the nose, &c. In addition to constant pain in the region of the antrum, the following symptoms may be enumerated—the escape of fetid sanies either into the nose on the patient's inclining his head to the opposite side, or through a fistulous opening, or one that has been formed by art for its escape; the traversing of the ulcer from the interior through the bony walls of the cavity and external soft parts (an opening of this sort may be effected through the cheek, near, or even into, the orbit, or through the canine fossa or palatine arch); flocculi mixed with the matter escaping from the sinus, which is never the case in simple muco-purulent secretion of the sinus. These flocculi sometimes choke up the natural opening of the cavity and cause the mucous and ulcerative secretions to accumulate, and distend its osseous walls until they ultimately give way or an opening is formed for their escape. It occasionally happens that the flocculi lodged in the nasal opening suddenly give way, and permit the matter to pass into the nose.

When the ulcer is of a fungous character, the matter secreted is thin, of a dark brown or blackish color, and has mixed with it blood and pus.* It is, says Deschamps, slightly painful, and can only be distinguished from other ulcers by the introduction of a bougie into the sinus; like polypus, it is capable of spreading and penetrating into every opening that will give it passage; but, in consequence of its being of a softer consistence, it makes less impression upon the surrounding parts.

If the ulcer be of a cancerous nature, the pain will be sharp and lancinating, affecting the whole of the side of the face; the matter will be serous, very fetid, and streaked with blood. If discharged through the natural opening into the nose, it will cause the pituitary membrane of the nasal cavity of the affected side to ulcerate, and to become exceedingly irritable and sensitive to the touch. The bones of the affected side of the face become softened or carious, the teeth loosen, the external soft parts inflame and ultimately ulcerate; openings are formed into the sinus, fever of a low grade supervenes, and a fatal issue is inevitable.

* Maladies des Fosses Nasales, sec. 2, art. vi, p. 263.

CAUSES.

A degenerated or altered state of the secretions of this cavity is said to be the most common cause of ulceration. This may be an exciting cause, and one of the most frequent; but were it not favored by constitutional predisposition, it would seldom give rise to the disease. Local irritation,—whether produced by an altered condition of its secretions, or by the presence of decayed or dead teeth, the roots of teeth, or a blow upon the cheek,—may be, and doubtless is, an exciting cause of ulcers in the mucous membrane of this cavity. This, however, in a subject of good constitution, would have to be very severe and continue for a long time, to occasion ulceration, and even then a cure would soon be effected by the restorative powers of the economy. It is only in bad or debilitated constitutions that malignant ulcers are met with in the maxillary sinus.

Deschamps, although he acknowledges that diseased teeth often exercise a morbid influence upon this cavity, and that the apices of the roots of these organs are sometimes in contact with its mucous or lining membrane, seems to doubt whether they have any agency in the production of ulcers; but his reasoning upon the subject is far from satisfactory. While he admits that, by the contact and adhesion of the dental periosteum and mucous membrane of the antrum, and the penetration of its floor by the roots of teeth, inflammation and ulceration may be produced, he denies that it can be positively proven. Although we may not be able to adduce positive evidence, the circumstantial proofs are so clear and strong, that no candid inquirer can, for a single moment, doubt that the disease in question, when favored by a bad habit of body, often results from dental or alveolar irritation. In reply to the question which he propounds, "How can the extraction of a tooth be of service in subduing inflammation of the mucous membrane with which the dental periosteum is only simply in contact?"* we answer, by this operation, a constant source of irritation may be, and often is, removed. Ulcers having absolutely formed, a cure cannot always be effected simply by the removal of the exciting cause.

* Maladies des Fosses Nasales, sec. 2, art vi, p. 259.

TREATMENT.

As in the case of mucous engorgement, the first indication is to give egress to the purulent matter; in this, as in the other affections, the opening should be formed at the most dependent part of the sinus, and this should be effected in the manner before described, through the alveolar border, or rather the alveolus of a molar tooth. It should be made large enough to admit the little finger, and if there be any teeth so much affected as to be productive of irritation to the parts subjacent to the antrum, they should be removed.

Free egress for the matter having been obtained, and all local irritants removed, the antrum should be injected, from time to time, with gently stimulating and detersive fluids. This, in cases of simple ulcer, if the constitution is not seriously impaired, will often be all that is required to effect a cure.

If the ulcer is of a fungous nature, the employment of escharotics, and sometimes even the actual cautery becomes necessary; this last should be repeated until the fungus is completely destroyed. With regard, however, to the employment of escharotics, such as the nitrate of siver, sulphate of copper, etc., for the purpose of destroying luxuriant granulations in ulcers, Sir E. Home is of opinion that it is better to combine them with some other substance, so as to prevent the immediate destruction of the granulations. He believes that after such destruction, the surface of the ulcer is more liable to reproduce them, than when they are removed by absorption; and for this reason he prefers, in the employment of caustics, to mix them with other substances, so that they shall only exercise a strongly stimulating effect, and thus cause the granulations to be gradually removed by the action of the absorbents.

The treatment of ulcers of this cavity is usually attended with more difficulty, on account of their concealed situation, than those of most other parts of the body. Among other things, Deschamps recommends injections of a decoction of quinine. In many cases, a lotion of sulphate of zinc may be used with advantage. The remedies to be employed in the treatment of ulcers of the maxillary sinus, as in the treatment of ulcers of

other parts should be varied to suit the indications of each particular case. In debilitated subjects, tonics, such as quinine and preparations of iron, are often serviceable. There are some cases in which mercurials are beneficial. Strict attention should always be paid to the regimen of the patient, and such general treatment adopted as may be best calculated to restore the constitutional health, for upon this the cure of the local affection often depends.

If the ulcer is of an irritable nature, warm injections (thrown into the antrum by means of a properly constructed syringe) of decoction of poppy heads, chamomile flowers, or the leaves of hemlock, will often prove beneficial in soothing the pain. Tincture of myrrh, diluted, or a decoction of walnut leaves, may be advantageously employed as injections in cases of indolent ulcers; the last of these is recommended as an application to ulcers of this character, in other parts of the body, by Hunezawsky, and both are favorably spoken of by Sir E. Home. This last named writer recommends "diluted sulphuric acid and the juice of the powder of different species of pepper in a recent state;" also nitrous acid diluted with water. The unguentum hydrargyri nitratis, mixed with lard, the ceratum resinæ, and the unguentum clemi, mixed with the balsam of turpentine, are also recommended. The application of ointment to ulcers of this cavity can rarely be made.

Many of the ulcers of the maxillary sinus are regarded as incurable, as for example, such as are of a cancerous nature and ulcerated fungus-hematodes. Although the resources of surgery have hitherto, in most instances, proved inadequate to the cure of these formidable diseases, nevertheless, they should be put in requisition, and we should endeavor to combat them by every means in our power. Deschamps says, the interior of the antrum should be exposed at the commencement of the disease He recommends the formation of a large opening above the alveolar ridge, if healthy; if not, through it, exposing as much of the cavity as possible. This done, he directs, if there is a cancerous tumor, that it be extirpated as thoroughly as possible by means of a curved and flat bistoury, or curved scissors. All that may have escaped removal by this means, he says, should be touched with the actual cautery. These are the only remedies to be

employed when the membrane is in a state of cancerous ulceration. The surgeon should destroy the parts in such a way as to leave only the osseous surfaces; he should also examine carefully these parts, and if necessary cauterize them. The disease having been thus removed, the surrounding osseous walls which have been cauterized will soon exfoliate; thus a chance for a cure will be afforded, of which, if the neighboring parts have not been too extensively involved, nature may avail herself. The administration of soothing and anodyne medicines are also directed. Arsenic has been employed with advantage as an external remedy in ulcers of this kind; and modern surgeons use the *potential* rather than the *actual* cautery.

The following case of fungous ulcer, complicated with alteration of the walls of the sinus, is taken from Bordenave's collection of observations on the diseases of this cavity, in the Memoirs of the Royal Academy of Surgery.

Case 12th. The subject in this case was a woman twenty-six years of age; who having exposed herself, while in a critical state of health, to cold air, was, in 1759, attacked with acute pains in the left side of her upper jaw, in the alveolar ridge of which were the roots of several decayed teeth. The following day her jaw was swollen, and although the pain ceased in a few days, the swelling continued, without any change in the appearance of the skin; nevertheless, her face was deformed in shape. The orbital plate of the maxillary bone became elevated, and the substance of the bone softened. The interior of the nose was affected, and the opening of the sinus into this cavity was closed. The matter collected in the antrum began to escape, twenty-two days after the attack, through the alveoli.

In January, 1761, the symptoms becoming more aggravated, she went to Paris for medical aid. M. Beaupreau was consulted, and on examining the affected parts, determined to extract the decayed teeth, which were considerably broken. They, however, adhered so firmly to the alveolar cavities that he could not move them without shaking their sockets. This deterred him from proceeding with the operation as he had begun, and he resolved to remove with a bistoury, the whole of the alveolar border from the lateral incisor to the first molar, with the teeth included. This done, he made a section of the softened bone with a pair

of scissors, in the direction of the cuspid. The antrum was much dilated; its membrane fungous and ulcerated. He then treated it with detersive injections, and adhesive dossils, dipped in oil of turpentine. In addition to these, mercurial ointment and red precipitate were used. Alterative pills, and soothing beverages were also prescribed; five days after this treatment had been commenced, the tumor had perceptibly diminished, the pus became of a better quality and less in quantity. At the expiration of two months, the discharge became mucous. Injections of lime water, at first strong, and afterwards milder, were used. The natural opening being closed, and continuing so, an opening through the base of the sinus was preserved. At the expiration of two months, the parts had recovered, and the general health of the patient was restored.

The medical treatment in the foregoing case was very proper; it accorded with the curative indications of the disease; but the surgical evidently involved a greater sacrifice of substance than was absolutely called for. The extraction of teeth was not, however, as well understood at that time as at present; to the want of proper knowledge and skill in this department of surgery may be attributed the unnecessary removal of so considerable a portion of the alveolar ridge. It is often necessary to make a very large opening into the sinus, but it is seldom requisite to make one as large as that made in this instance; although nearly the same treatment was adopted in a case of a somewhat similar nature by Bourdet. When the subjacent bone and alveolar border are in a carious or necrosed state, their removal would be proper, and there are diseases that occur in this cavity which render the operation necessary; but in neither of the cases just noticed, were the bones so carious, nor was the nature of the disease such as to require so large an opening. In the first case, the outer wall of the sinus, as would seem from the description given, was softened, but in the other, Bourdet says, the bones were not diseased.

It sometimes happens that when the opening through the alveolar border is very large, it never closes, and when the natural opening becomes obliterated, it is requisite to preserve an artificial one; in either of these cases the employment of an artificial obturator is necessary to prevent particles of food and extrane-

ous matter from getting into the sinus. Of this we shall hereafter speak.

The history of many highly interesting cases of ulceration of the mucous membrane of this cavity, might be introduced, but as this form of diseased action is so often complicated with caries, necrosis, and other alterations of its osseous walls, we have thought it would be as well to reserve them until we treat of those affections; which we shall now proceed to do.

CHAPTER SIXTH.

CARIES, NECROSIS AND SOFTENING OF THE BONY PARIETES OF THE MAXILLARY SINUS.

The osseous walls of the antrum, and somctimes the whole of the subjacent alveolar border, and also the superior maxilla, the nasal, palatine and orbital and malar bones, as well as some that belong to the base of the cranium, are involved in caries or necrosis. Mollities ossium, though rarely occurring in the alveolar ridge, frequently affects the walls of the sinus. Caries may affect a considerable portion of both for a long time, without completely destroying the vitality of the diseased parts. During its continuance fetid sanies is discharged from one or more fistulous openings through some part of the cheek, alveolar ridge, gums, palatine arch, or into the sinus, and from thence through the natural opening into the nose. The disease eventually terminates in the decomposition and death of the parts affected ; they are then separated from the living bone and thrown off, in other words, exfoliated. Although caries ultimately causes the death of the bone affected by it, it does not always precede the destruction of vitality. The occurrence of necrosis, therefore, although it may result as a consequence of caries, is not necessarily dependent upon it.

When the parietes of the antrum or alveoli are affected by necrosis, the soft parts in contact with the diseased or dead bone, inflame, ulcerate and discharge fetid ichorous matter. The gums sometimes become gangrenous and slough. The destruction of the vitality of the osseous parts often progresses very slowly, and thus, piece after piece is exfoliated, until the disease is arrested.

Besides these affections, it not unfrequently happens that the osseous parietes of this cavity are so softened as to be easily bent. This alteration of the bone, as well as the others just

noticed, are, in nearly every instance, preceded by some other form of disease.

The annoyance to the patient, occasioned by caries and necrosis of the bony walls of this cavity or of the alveoli, is very great. The fetor of the sanies is sometimes almost insufferable; the matter often excoriates and inflames the parts with which it comes in contact, to such a degree, as to cause them to become exceedingly sensitive and not unfrequently to ulcerate.

SYMPTOMS.

It is sometimes difficult to distinguish caries and necrosis of the bony parietes of the antrum from some of the other diseases of this cavity. They, therefore, often exist for a long time without being suspected. The signs that indicate mollities ossium, or softening of the walls, are such as not to be easily mistaken for those of any other affection. In this disease, the walls of the sinus yield to pressure, and regain their former shape when the pressure is removed. Its existence, therefore, may always be known by this sign, and as this is sufficient, it is not necessary to enumerate any others by which it is characterized. Caries and necrosis not being so easily detected, often make considerable progress before their existence is ascertained. The fetor and appearance of the matter discharged do not always furnish a diagnosis that can be relied upon, inasmuch as some of the diseases that occur here are marked by secretions equally as offensive as the sanies resulting from caries or necrosis, and not unlike it in appearance. Their existence may, in most instances, be inferred, from the discharge of dark colored fetid sanies. The exfoliation of pieces of bone will set all doubt at rest.

Caries or necrosis may often be detected by perforating the antrum and exposing the denuded or diseased bone; or when there is an external opening, by probing it. In this way any loose or dead bone may be felt with the instrument, and the diagnosis in either case will be satisfactory.

When caries or necrosis is situated in the alveolar border or floor of the antrum, its existence can be more readily ascertained. The occurrence of either in the alveolar ridge, causes the gums to inflame; to assume a dark purple or livid appearance; to

separate from the sockets of the teeth, and frequently to slough in large pieces and expose the carious or necrosed bone. When situated in the floor of the antrum, the rough denuded bone may be easily felt with a probe or stilet, introduced through the fistula of the gums or the alveolus, through which the matter is discharged.

The pain accompanying these affections does not constitute a diagnosis of much importance, since this is common to several other diseases.

CAUSES.

The immediate cause of caries and necrosis of the osseous walls of the antrum maxillare is suppurative inflammation, or the destruction of their periosteum; these may result from a purulent condition of the secretions of the mucous membrane, engorgement, tumors, a blow upon the cheek, or from other kinds of mechanical violence; they may also arise from the irritation produced by diseased teeth. Fouchard says he saw, in the Anatomical Museum of the University of Copenhagen, a preparation in which there had been caries of the bones of the face, produced by a molar tooth, the crown of which, having turned outward, had penetrated the maxillary sinus. The pressure of incarcerated fluids may, perhaps, be regarded as the most frequent cause; and from this, too, result some of the most aggravated forms of disease that ever attack this cavity.

A morbid action kept up in the periosteum for a long time, by ulceration of the lining membrane, or any other aggravated form of disease in the sinus or neighboring soft parts, is apt to give rise to caries of the bone; but when the inflammation is so severe as to cause the immediate destruction of the periosteal tissue, necrosis at once takes place.

Softening of the bone seems to result from some alteration in the progress of growth or development; in consequence of which, the normal proportion between the animal and mineral constituents of the bone are changed. Inflammation and ulceration of the mucous membrane is its almost invariable attendant when it occurs in the walls of the antrum. What this altered state is, and why it should be so purely local as in some of these cases, are questions not easily answered.

TREATMENT.

Complicated, as caries, necrosis and other diseases of the osseous walls of the maxillary sinus most frequently are, with other affections of this cavity, their cure is often difficult and generally tedious. The first indication to be fulfilled, however, in their treatment, as in the case of engorgement, and of a muco-purulent condition of the secretions, is to obtain free egress for any fluids which may have accumulated here. This may be effected in the manner before described. If, in addition to this, the disease of the osseous tissue is complicated with any other affection of the sinus, such means as are necessary for the cure of that affection should at once be employed; but it is not necessary here to describe the treatment of the complicating diseases, as that has already or will hereafter be done.

Deschamps, in treating upon the osseous diseases, recommends the employment of detersive and stimulating injections, a decoction of quinine, tincture of myrrh and aloes, &c. These last, he says, may be introduced as injections, or by means of pledgets moistened with them. He also directs the cavity to be "cleared of all foreign matter which may have obtained admission into it." This treatment, having a tendency to promote a healthy action in the lining membrane, will often be all that is required. It should be continued until the caried or necrosed bone has exfoliated, and the secretions of the antrum cease to exhale an offensive odor. The dead bone having exfoliated, a cure is generally soon effected.

It sometimes happens that the disease of the bone has been produced by some very malignant and incurable affection of the soft parts. In this case, the resources of art will, of course, prove unavailing. When the disease of the bone has extended itself to the greater part of the superior maxilla and the bones with which it is connected,—the nasal, palate, ethmoid, &c.—the most that can be hoped for, from the skill of the physician, is a palliation of the symptoms. Art, in such cases, can seldom effect a cure; whilst there are others in which it can only retard the progress of the disease, or assist nature in her efforts to separate the dead from the living bone.

It is impossible to lay down rules for the treatment of disease in the walls of the maxillary sinus, from which it will not be necessary occasionally to deviate. It will be sufficient to state, that where they are extensively involved in caries or necrosis, it will be proper, in addition to perforating the base of the sinus, if by this means the dead bone cannot be so exposed as to enable the surgeon to detach it from the living, to cut away the whole of the alveolar border beneath the cavity, or to penetrate the sinus above it, or even, as Deschamps recommends, "through the cheek itself, whether there be a fistula penetrating those parts or not." Having, by this means, exposed the necrosed bone, it should be carefully detached from the sound, and removed.

The character which the affections of this cavity put on, being determined by the state of the constitution or some particular vice of body, it often becomes necessary in their treatment, to have recourse to general remedies. If the subject is of a scrofulous or scorbutic habit, or is affected with any specific constitutional vice, such remedies as are indicated by this affection of the general system should be employed. Although the character and malignancy of the disease are thus determined, its occurrence seems to be dependent upon local irritation. Its continuance, in many instances, results from this; and the cure, in such cases, soon follows the removal of the cause that gave rise to it, as in the following case:

Case 13th. L. S——, a maiden lady about thirty years of age, of a scorbutic habit, had been affected with pain in her left cheek and alveolar ridge for nearly two years, which at times was almost insupportable. Nearly all her teeth were affected with caries; from around the necks of several, on the left side in the superior maxilla, fetid sanies had been exuding for two or three months, and her appetite had become greatly impaired. A tumor half the size of a black walnut, having formed upon the palatine arch of the affected side, she became alarmed, and in the fall of 1840, came to Baltimore for medical aid. She applied to Professor T. E. Bond, who, after investigating the case, and satisfying himself that the affection was the result of the diseased condition of her teeth, advised her to place herself under our care, which she did on the following day.

The sockets of four of the teeth of the affected side, in the

superior maxilla, were, on examination, found to be in a necrosed condition, as was also a part of the palate bone of the same side. The gums around these teeth had separated from the alveolar process, and had a dark, livid appearance. A thin, dark-colored, ichorous matter, which, when brought in contact with silver, almost instantly turned it black, was constantly exuding from between the gum and the necks of the teeth. The left nostril was dry, and the opening from the sinus had evidently closed. Exceedingly fetid matter had been discharged from it during the early stages of the disease. The tumor on the left side of the arch of the palate was soft and elastic. When pressed, dark-colored sanies was discharged from the alveoli, and then, for a time, ceased.

The alveolar processes being in a necrosed and loose condition, it was with some difficulty we succeeded in removing the bicuspids and the first and second superior molars of the left side, without bringing their sockets with them. The operation was followed by a discharge of a considerable quantity of fetid sanies; and, in a few days, the alveoli having become completely detached from the sound bone, we removed them, together with a part of the floor of the antrum. The opening thus formed into the sinus was large enough to admit the end of the forefinger. Several small pieces of bone were afterwards exfoliated from where the teeth had been extracted, and three pieces from the left side of the arch of the palate.

Without any other treatment, the place from which the teeth and alveoli had been removed had, in about seven weeks, become entirely covered with firm and healthy granulations, except the opening that communicated with the maxillary sinus. From the opening into the antrum, fetid matter was still discharged. This became less and less offensive, until, at the expiration of six or eight weeks, the opening into the nose having become re-established, it lost its fetid odor, and the aperture at the base of the sinus soon after closed. Thus, in a little more than three months, a complete cure was effected. The patient left the city in the following spring, and we have not since heard from her.

The following case is abridged from Bordenave's Observations on the Diseases of the Antrum Maxillare, as published in the Memoirs of the Royal Academy of Surgery.

Case 14th. A man, whose right superior maxilla, at the

upper part, had been swollen for about three months, had, at the same time, a soft tumor on the anterior of the palate, which, on being pressed, caused matter to be discharged from the nostril of that side. These affections, together with tumefaction of the gums, looseness of several of the teeth, and fetid breath, induced M. Planque, under whose care the patient was placed, to suspect suppuration of the maxillary sinus, complicated with a scorbutic diathesis of the general system. The molars, which only adhered to the gums, having been extracted, matter was discharged through their alveoli. A portion of the maxillary bone was now discovered to be carious, and this, in about a month, began to loosen, and after some time, a piece of about an inch and a half long, and half an inch in width, exfoliated. The external tumor disappeared; the walls of the sinus approximated, and a cicatrix ultimately closed the opening.

The details of many similar cases are on record, but it would be extending the limits of this part of the work too far to introduce them here. The history of the cases already given will suffice to illustrate the treatment of these affections. We would, however, have given a case of mollities ossium of the walls of this cavity, had we not, while treating of ulceration of the lining membrane, quoted one in which it had become complicated with this affection.

It sometimes happens, when a very large opening has been formed through the inferior part of this cavity, that it does not always readily close. It is true that this does not often occur, unless the natural opening has become obliterated. When the parts do not manifest a disposition to unite, the practice introduced by Bordenave and Scultet, which consists in cauterizing the interior circumference of the opening, will, in most instances, prove successful. If this and all other means fail, the opening may be closed by means of an obturator of fine gold. This should be accurately fitted to the parts, and secured, by means of a broad clasp, to a molar or bicuspid tooth, and if there be none suitable on this side of the mouth, to which it can be applied, the gold should be extended to one on the opposite side. If it be necessary to replace the lost teeth with artificial ones, these may be so mounted that the plate upon which they are set shall cover the opening into the maxillary sinus, and thus obviate the necessity of any other obturator.

CHAPTER SEVENTH.

TUMORS OF THE LINING MEMBRANE AND PERIOSTEUM OF THE MAXILLARY SINUS.

The lining membrane and periosteum of the maxillary sinus occasionally become the seat of fungous and other tumors, and in consequence of the concealed situation of the cavity, morbid growths originating in it often make considerable progress before they attract attention; hence, the efforts of art for their cure, which might otherwise frequently be successful, in most instances prove unavailing. The presence of a tumor may give rise to all the diseases to which its osseous walls are liable, as well as to most of those incident to its soft tissues. As soon as the morbid growth has filled the sinus, it presses upon the lining membrane, excites inflammation, and sometimes ulceration, causing its secretions to become vitiated. A diseased action is communicated to the periosteum of the surrounding osseous walls, this ceases to furnish the hard tissues, with the healthy juices which they require for their preservation; the periosteum thickens, ulcerates, and is destroyed, or exudes a corrosive fluid. The bony parietes are softened or become affected with caries or necrosis, and one or more fistulous openings are formed through the cheek, alveoli, or palatine arch.

These are not the only effects that result from tumors situated in this cavity. As they increase in volume, after having filled the antrum, they gradually distend and displace its bony walls; the floor of the orbit is sometimes elevated, and the eye more or less forced from its socket; the palatine arch and alveolar ridge are depressed, and the teeth loosen and drop out. When the tumor is of a soft fungous nature, it not unfrequently escapes through the alveoli into the mouth, and after forcing the jaws asunder to their greatest extent, protrudes from it in enormous masses. Bertrandi gives the history of a case of polypus excrescence of the antrum, which, after having destroyed the

palate, anterior part of the maxillary bone, and filled the mouth, forced itself up into the orbit, elevated its roof, pressed upon the brain, and ultimately occasioned apoplexy and death. Other similar cases are on record. Mr. Cooper says there are three specimens of diseased antrum in the museum of the London University College. The tumor in two of these had "made its way from the antrum to the brain." The third was taken from a patient of his, which had died. The tumor in this case, which was of a medullary and scirrhous character, forced itself up into the orbit, displaced the eye, and, ultimately, caused the death of the patient. The same author mentions another case; the subject was a boy in St. Bartholomew's Hospital, who had a tumor of the antrum, which "made its way through the orbital plate of the frontal bone and cribriform plate of the ethmoid into the cranium," and though the portion of it that entered the brain was as large as a small orange, he says the boy was in a comatose state only about forty-eight hours previously to his death.

Tumors occupying the maxillary sinus do not always originate in the lining membrane or periosteum. They sometimes arise from the pituitary membrane of the nose, frontal sinus, or ethmoidal cells, and after having found their way into this cavity, augment in size, until they produce the effects just described. Some suppose that the morbid productions found here, originate more frequently in the cells of the ethmoid bone, than in the lining membrane of this cavity.

We are disposed to believe that this opinion is not well founded, and that it has chiefly resulted from the great liability of most kinds of tumors of this cavity, to be reproduced after having been extirpated—which is attributable to the continuance of the cause that gave rise to them in the first instance, or to their imperfect removal. That they do, however, sometimes originate in the ethmoidal cells, there can be no question.

It sometimes happens that tumors having their seat in the antrum, after having filled it, make their way into the nose, where they acquire a size equal to, or even greater, than that which they had previously obtained, thus dividing themselves, as it were, into two parts—one occupying the antrum, and the other one of the nasal cavities. Occurrences of this sort are not unfrequent, and they sometimes mislead as to the real seat

of the disease. Thus, a polypus of the antrum is occasionally mistaken for one of the nose, and the error frequently not discovered until an attempt is made to remove it.

The character of morbid growths, in this cavity, is exceedingly variable, according to the causes that give rise to them and the state of the constitutional health of different individuals. They not only vary in their appearance and structure, but in their degree of malignancy. Some are of a healthy flesh-color, soft, sensitive, but not painful, and present a smooth, regular surface; others varying in their consistence from hard to soft, and in their color from pale yellow to deep red or purple, presenting a rough, irregular, and not unfrequently ulcerated surface, and are more or less sensitive to the touch. Some have their origin in the mucous membrane; others, both in this and the periosteum. Some are attached by a broad base; others, only by a mere peduncle.

As it regards this latter description of tumors, which are usually designated by the name of polypi, their occurrence in the maxillary sinus is questioned by some writers. Sir Benjamin Brodie does not believe they are ever found in this cavity;* and in this opinion Mr. S. Cooper fully concurs; yet that they are occasionally met with, seems to be conclusively established. A case described by M. Bertrandi in his treatise on Operative Surgery, page 369, has already been referred to; and Bordenave, in his Observations on the Diseases of the Antrum Maxillare, gives the history of a case treated by M. Doublet. Rusch declares that he has twice seen polypus of this cavity, and Pettit, Levrette, and other writers also affirm that they have found polypi here.† It must be admitted, then, that polypi in the maxillary sinus, although very rare, do sometimes occur: although other descriptions of tumors are more frequently met with in this cavity. Of these, some are of a simple fibrous, sarcomatous, or osteosarcomatous nature,‡ and when thoroughly extirpated, are seldom reproduced; others are of a medullary or carcinomatous character. These last, although originating in the mucous mem-

* London Medical Gazette, for December, 1834, p. 850.

† Traite des Maladies de la Bouche, tom. 1, p. 212, and Polypes de la Matrice, de la Gorge, et du Nez, p. 253.

‡ Professor Reese's Appendix to Cooper's Surgical Dictionary, American edition, 1842.

brane, are very liable to be reproduced after their removal, and generally occasion the death of the patient.

It sometimes happens that several fungous tumors spring up from opposite points. The chances of cure, when this is the case, especially if they are of a malignant character, are greatly lessened.

Tumors of this cavity seldom grow very fast during the early stages of their formation; but, as they enlarge, the neighboring parts become involved in the diseased action, and they assume a character of greater malignancy and increase more rapidly in size.

SYMPTOMS.

The occurrence of tumors in the maxillary sinus is rarely accompanied by symptoms differing materially from those occasioned by many of the other affections that locate themselves here, previously to their having obtained a size sufficiently large to fill it. After they have filled the sinus, the indications soon become less equivocal. Swelling of the cheek, depression of the palatine arch and alveolar ridge, loosening of the superior molar teeth of the affected side, inflammation and sponginess of the gums, elevation of the floor of the orbit, and protrusion or concealment of the eye, are symptoms which result from the presence of tumors in this cavity; but they are not peculiar to these affections, as many of them are produced by mucous engorgement of the sinus. When to these is superadded the discharge of bloody sanies from the nose, or from one or more fistulous openings through the cheek, alveolar ridge, or palatine arch, the diagnosis will be conclusive, and the existence of a tumor in the antrum established beyond doubt.

There are also other signs by which the occurrence of a morbid growth in this cavity may be known; as, for example, dropping out of the superior molars of the affected side, and the protrusion of portions of the tumor through the alveoli.

The pain is seldom severe until the tumor has filled the cavity, unless the excrescence is, from the first, of a malignant character; as it augments in size and forces the walls of the sinus asunder, it becomes more and more severe. Sometimes, during the pro-

gress of the disease, it becomes most excruciating. In a case of fungus-hematodes of this cavity, which the author had an opportunity of witnessing in 1835, the patient was in the habit of taking upwards of two tea-spoonfuls of black drop at a time, for the procurement of ease and sleep.

In addition to the foregoing symptoms, several of the affections already described, together with their attendant symptoms, not unfrequently result from tumors in this cavity. Inflammation and ulceration of its lining membrane, a purulent condition of its secretions, caries, necrosis, and softening of its osseous walls, seldom fail to attend some of the stages of the formation of the morbid productions under consideration. It is unnecessary to mention the symptoms peculiar to each variety of tumor, as they are given by writers on general surgery.

CAUSES.

Most writers on the affections of the maxillary sinus, are of opinion that tumors in this cavity result spontaneously, as a consequence of some specific constitutional vice, independently of local causes. We do not believe that they are ever developed spontaneously. That a bad habit of body, or some constitutional vice is necessary to their production, is very probable; but that this is capable of giving rise to them in parts uninfluenced by local irritation, we think exceedingly questionable. Having, however, already expressed our views with regard to the agency of particular habits of body and constitutional vices in the production of disease in this cavity, it will not be necessary to repeat what we have before said upon the subject. It will be sufficient to remark that most, if not all of the morbid excrescences met with, result from local irritation, favored by constitutional vices; and that both are necessary to their production.

TREATMENT.

It is only in the earlier stages of the formation of tumors in this cavity, that surgical treatment can be adopted with success, and even then, their entire extirpation is absolutely essential, otherwise a speedy return of the disease is certain. But, pre-

paratory to the removal of the diseased structure, a large opening should be made into the antrum, so as to expose as much of it as possible. Deschamps recommends as the most proper place for effecting this, when the alveolar ridge has been started, the removal of the first or second molar, and the perforation of the sinus through its socket with a "three-sided trocar of suitable dimensions." When the alveolar ridge and teeth are sound, he directs the opening to be made through the outer wall of the sinus above the ridge, and this, he thinks, on account of its being more direct, is preferable to the other mode. An opening may be easily effected in either way into the sinus, as its walls are generally so much softened as to offer but little resistance.

When the opening is made through the external parietes, the instrument recommended by Mr. Thomas Bell, for cutting away the bone after it has been exposed, is a "strong hooked knife," which is probably as well adapted to the purpose as any that can be used. Some surgeons employ strong curved scissors, but the hooked knife we think preferable.

A free opening having been effected, a finger of the operator should be introduced, and the nature of the diseased structure ascertained. This done, he will be able to determine what course to pursue for its removal. If the tumor partakes of the character of polypus, it may be seized with a pair of forceps, and torn away; if it be attached by a broad base, its extirpation will be most readily effected with a knife. But even with this, it is often exceedingly difficult to effect its total removal; so that it not unfrequently becomes necessary to employ the actual or potential cautery; for, if any small portions be left behind, as has before been stated, a reproduction of the disease will generally very soon take place. When the disease has originated, or is seated in the periosteum, the actual cautery has proved to be the most effectual means of preventing its return. French surgeons have applied it with great success. Desault, in a case of fungous tumor, succeeded in effecting a cure, after three applications. The root of the disease can often be destroyed by the employment of this, when less effectual means would fail. But it is important, when it is had recourse to, that it should have such a degree of heat as to accomplish the object instantanously, else the inflammation that would otherwise be excited in the

surrounding parts, by its application, would greatly retard, if it did not prevent, the cure. Mr. Thomas Bell says, "the white heat should be employed."

In remarking upon the bold practice of the French surgeons in the treatment of these affections, the author just quoted remarks: "It is worthy of our praise and imitation; the timidity which, until very lately, almost excluded the use of the actual cautery in this country, has been one cause, and that a very prevalent one, of failure in the treatment of some of these cases; but it is not so easy to account for the still more culpable dread, which has, in so many instances, prevented any attempt being made to extirpate the disease; a degree of pusillanimity, which is at once an opprobrium on the profession and a fatal injustice to the sufferers; who, thus abandoned to the unrestrained progress of the disease, are left to perish by a lingering and most painful process, without even an attempt being hazarded for their relief."

The foregoing comparison, instituted by Mr. Bell, between the practice of the French and English surgeons in the treatment of tumors of the maxillary sinus, is certainly correct. But it is due to truth to say, that the bold practice of the former has been fully and successfully emulated by American surgeons. Dr. A. H. Stevens, Professor of Surgery in the University of New York, in 1823, in a case of fungous tumor, attached by a broad base to the lower part of the antrum, removed a large portion of the lower and anterior parts of the upper jaw. The patient recovered, and is said to be living, twenty years after the operation.* In 1841, Dr. J. C. Warren, of Boston, for a case of cephalomatous tumor of this cavity, removed the superior maxillary bone. This operation was also successful.† The same operation was performed soon after, and for the removal of a tumor of the antrum with success, by Dr. R. D. Mussey, of Cincinnati;‡ and Dr. Fare, of Columbia, South Carolina, has performed the operation twice with success.

Thus it will be perceived, that the disease under consideration not unfrequently calls for one of the most formidable operations

* Appendix to Cooper's Surgical Dictionary, p. 30.

† Boston Medical and Surgical Journal for 1842.

‡ Western Lancet for 1842.

in surgery, and that by it, many unfortunate sufferers have been snatched from the very jaws of death. The application of the cautery, however, often becomes necessary to prevent a reproduction of the excrescence, and there are many cases in which it cannot be repressed even by this means. The result of the most thorough and best directed treatment depends on the state of the constitution and the nature of the disease. In depraved habits and shattered constitutions, if the tumor is of a carcinomatous character, a cure need never be expected.

The hemorrhage, during the operation for the removal of tumors of the antrum, is sometimes so profuse as to require very prompt and active means to arrest it. It may, generally, however, be controlled by the employment of compresses and suitable styptics; should these fail, the actual cautery must be resorted to.

The history of the following cases taken from various works, will perhaps furnish a more correct idea of the methods of treatment most proper to be pursued than any description which could otherwise be given. The first three cases are taken from the Memoires de l'Academie Royale de Chirurgie.*

Case 15th. A man about thirty-five years of age, had a fleshy tumor, the size of a large pea, situated in a space formed by the decay of the first and second superior molars of the left side. This tumor caused a dull pain; it was excised, and the actual cautery applied to arrest the bleeding and destroy the remaining portions of the excrescence. It re-appeared, and three months after was double the size of the former, and impeded mastication. The two decayed teeth were loose, and the others were painful; and fetid matter escaped through the nose and mouth.

After the extraction of the two decayed teeth, M. Dubertrand, discovering that the tumor had its seat in the antrum, seized it with polypus-forceps and brought the whole of it away. After the extraction of the tumor, the opening through the alveolus was large enough to admit the little finger. M. Dubertrand next destroyed such portions of the alveoli and maxillary bone as were decayed. After the extirpation of the tumor, he found it necessary to introduce a plug of cotton into the antrum, to arrest the hemorrhage that followed the operation.

* Tome 13, obs. 1, 5 and 7th, pp. 372, 387 and 424.

The secretions of the maxillary sinus ceased to exhale an unpleasant odor; in three days they became healthy, and in less than one month, the patient was restored to health, and the opening from the mouth into this cavity was closed with firm granulations. The tumor just described was of the simple non-malignant kind, but had it not been completely eradicated, it would, doubtless, have soon re-appeared.

Case 16th. Acoluthus reports the case of a woman thirty years of age, who, in 1693, came to Pologne in Silesia, in search of aid for a peculiar disease of the antrum, under which she was laboring. Some time after the extraction of a tooth from the left side of the upper jaw, a small tumor appeared in its alveolus, and made such progress that in two years it attained the size of the doubled fist. It occupied nearly the whole cavity of the mouth, and distended the jaw to such a degree that it was feared it would rupture it. The lower jaw was depressed, the lips could not be made to meet, and the tumor increased so fast, that in a few weeks the woman's life was despaired of—being threatened with death from suffocation, hunger and thirst. Under these circumstances, Acoluthus determined to attempt a cure.

The tumor was very hard, and occupied the greatest part of the palatine arch; the upper teeth of the left side were in its centre. The operation was commenced by enlarging the mouth, beginning at the commissure of the lips, and passing it transversely through the cheek. This enabled Acoluthus to attack the exterior of the tumor with a curved bistoury. The excrescence was as hard as cartilage, and scarcely yielded to cutting instruments applied by a strong hand. He, however, succeeded in removing three or four teeth, together with a portion of the superior maxillary bone. The operation, as yet, had extended only to the external half of the tumor: the other, which filled the palatine fossa, he says, it was impossible to bring away. The removal of that was effected only by piecemeal, and at different times. The operation was long, laborious and very painful. The actual cautery was applied to the bleeding vessels and fungous flesh. The appearance of the patient, a few days after the operation, was such as to inspire hope of a favorable termination of the disease. The actual cautery was applied several times, and finally there were no indications of the re-appearance

of the excrescence, except at the point where it had first originated. Some portions of bone were afterward found to be carious, and the removal of these was followed by a prompt and speedy cure.

This operation is alluded to by M. Velpeau, as embracing the removal of the entire superior maxillary bone; but from the description here given, it would appear that only a small portion of the bone was taken away. The alveolar ridge and anterior parietes of the sinus only were removed. The history of the case, however, imperfect as it is, proves that the resources of art are adequate to the cure of many of the most formidable of the affections of this cavity, if they are not delayed too long.

Another case, taken from the Memoirs of the Royal Academy of Surgery, is described by the author in his dissertation on the diseases of this cavity; for the particulars of which the reader is referred to page 131 of that work.

Case 17th. A young lady of Picardy having been exposed to the changes of weather for three years, in attending to business which required her to be much on horseback, experienced, at the end of the first year, a chilly sensation in her left cheek; this increased, and the cheek became swollen, the molar teeth of the affected side loosened, and two dropped out.

The swelling of the cheek increased, and she was affected with lancinating pains in that side of the face; the breath became offensive, and she lost two more teeth. Becoming alarmed, she went to Rouen to obtain medical advice. Receiving no satisfaction, she went to Paris, and applied, November 20th, 1740, to M. Croissant de Garengeot, who found her face greatly disfigured. Her mouth, he says, was on the right side, the left side of her nose much elevated, the left cheek very large, and the upper lip greatly thickened. Bluish flesh of the size of an olive occupied the alveoli of the teeth which had dropped out; the left side of the roof of the palate was thrown inward, and resembled the exterior projection of the cheek. The anterior wall of the antrum and left nasal bone had become softened, and the whole cavity was filled with fungous flesh.

M. Garengeot commenced the operation by seizing the bluish excrescence which had appeared through the alveoli, with a

hook and cutting it away; and he says he incised transversely, every day, from within the mouth, the buccinator muscle, and brought away part of it, as well as the flesh which so much augmented the size of the jaw.

The hemorrhage was so abundant, that it was impossible to proceed further with the operation. The excrescence was rapidly reproduced after each operation; these excisions were repeated seven or eight times in six weeks, and the hemorrhage each time was very great. The seat of the disease was in the anterior of the sinus. The fungous flesh contained in this cavity was removed, as well, also, as some osseous projections.

The excrescence continuing to be reproduced, the patient no longer refused to have the actual cautery applied; the use of which was resorted to twice a day for eight days. The success, says M. Garengeot, which followed this treatment, was incredible. The flesh soon took on a healthy consistence, about two-thirds of the palatine arch returned to its natural situation, and the bad odor of the mouth gradually disappeared.

The application of the cautery was continued once a day for three weeks, and the patient did nothing more than to use a slightly stimulating and astringent gargle. On the 20th of March she returned home cured.

It is very probable that had the first operation in the case just described been thorough, there would have been no return of the disease, for it is evident from the description which M. Garengeot gives of the operation, that the seat of the affection was not reached until it had been repeated seven or eight times; and then, we think it very likely, not until he had recourse to the actual cautery.

The utility of the actual cautery, not only for the purpose of thoroughly destroying every remaining vestige of fungous tumor of the antrum after their removal, but also for the suppression of hemorrhage, would seem to be fully established by the result of the treatment of cases sixteen and seventeen.

The employment of arsenical preparations has, in some instances, been found highly advantageous in repressing the growth of fungous excrescences. The following case is cited by Mr. Thomas Bell as an example.*

* Anat. Physiol. and Diseases of the Teeth, p. 283.

Case 18th. "James Woodley was admitted into Guy's Hospital September 4th, 1821, for a fungous exostosis which arose from the antrum maxillare, and made its way through the palate. After his admission he had the fungus removed two or three times, and a variety of eaustie applieations were afterward made use of, notwithstanding whieh the tumor reappeared. At length Sir A. Cooper, after having made an ineision from the eorner of the mouth outward through the eheek, removed the tumor from a greater depth than had previously been effeeted. After this operation the wound in the eheek readily healed, and the following strong solution of arsenie was daily applied to the part from whenee the tumor had been removed.

℞ Arsenic. oxid. alb. ℥ vi.
Potass. subcarb. q. s.
Aq. distillat.
Misce et fiat solutio.

"The solution required to be diluted in the first instanee on aeeount of its oecasioning him a good deal of pain; in a few days, however, he used it of the strength mentioned in the formula. It was applied regularly every afternoon, after whieh he did not take any food until the following day. At the time of its applieation he had a pieee of oiled silk, of a horse-shoe shape, passed into the mouth, its sides being turned up to prevent the solution eseaping into the mouth; his head then hanging down over a basin, a pieee of sponge moderately saturated with the solution was applied to the disease upon the oiled silk, and pressed against the part; sueh of the solution as was then pressed out, passed along the ehannel of the oiled silk into the basin over whieh the head was hanging, and the saliva eseaped behind the oiled silk into the same utensil. He kept the sponge in this situation until it gave him eonsiderable pain, when it was removed and the mouth earefully washed. He suffered great pain in his mouth during the period of cure; but the arsenie did not produee any other unpleasant symptoms. This applieation was continued for a few weeks, at the end of which time he was completely eured; a eavity was left in the site of the tumor, which, however, gradually beeame eovered by a eontinuation of the membrane which naturally lines the palate.

The maxillary sinus is sometimes occupied by fungous tumors, originating in the alveoli of the molar teeth, or from the roots of these teeth. The following is a case which came under the observation of the author in February, 1846:

Case 19. Miss L——, of Baltimore, aged twenty-two, of a bilious temperament, called to consult us in relation to the condition of her teeth, on the 10th of February, 1846. On examination, the crowns of the first and second superior molars of the left side were found badly decayed, and from the destruction of the greater portion of their sockets, much loosened. The gums on either side were swollen, spongy and had a livid appearance; from between the edges of which, whenever the teeth were touched, thin, fetid matter, occasionally streaked with blood and pus, was discharged. She complained of a sensation of fullness, and occasionally of slight pain in her left cheek. The affected molars had been troublesome and sensitive to the touch for nearly three years; arising, as she supposed, from a severe cold, for about that time she suffered, for nearly two weeks, the most violent pain in these teeth. She had several times, subsequently, been urged by her friends to have the teeth removed, but the dread of pain had prevented her from submitting to the operation.

Fearing that the diseased condition of the sockets of the affected molars had extended to the antrum, and confident that the parts immediately involved could not be restored to health while they remained in the mouth, we advised her to have them removed, to which, after much persuasion, she consented.

The gums being separated from the teeth, we grasped the first molar with a pair of forceps, and proceeded to remove it. It readily yielded to a very slight force, but the moment this was applied, a gush of blood issued from the left nostril, and the complete removal of the tooth was prevented by a fungous excrescence which had originated at the extremity of its roots, and passed up into the antrum; the true nature of the affection at once suggested itself. The tooth, after being partially removed, was liberated by cutting the excrescence.

The hemorrhage for a few minutes was profuse, but after it had partially subsided, the socket was examined, when an opening was discovered through the floor of the antrum, large enough

to admit the end of the little finger; the fungous peduncle, after its separation from the roots of the tooth, having contracted, had passed up into this cavity. This was now partially explored by means of a small probe, and found to be nearly filled with a soft spongy tumor, which bled profusely from the slightest injury. Finding a portion of the floor of the antrum, back of the tooth which had just been extracted, in a necrosed condition, and partially exfoliated, we extracted the second molar, (which also had a fungous excrescence upon the extremity of its roots, passing up through an opening from the socket into this cavity,) and then removed the dead bone. This occupied the space between the two teeth.

An opening was now formed through the floor of the antrum, of about an inch in length, and more than a quarter of an inch in width, which enabled us to explore the interior of the cavity more thoroughly than we had previously been able to do. The tumor, which at first had completely filled it, had, from the hemorrhage occasioned by the laceration of the vessels, become so reduced in size, that we were enabled to pass a small curved probe between it and the walls of the sinus, thus proving that it had no connection with any part of the cavity. There was, therefore, no danger that the excrescence would be reproduced after its removal, which was done piecemeal, with a small sharp-pointed hook, and a narrow-bladed knife. The opening through the alveolar border, in the antrum, soon closed, and the parts, in a short time, were restored to a healthy condition.

What would have been the result, in this case, had the teeth been permitted to remain, is not difficult to conjecture. The pressure of the excrescence, as it augmented in size, would have caused necrosis of the entire floor (if not of the walls of the antrum), which would ultimately have become displaced and detached, carrying the diseased teeth with it. But, in the meantime, other parts might have become involved in a worse and more unmanageable form of disease.

In the treatment of tumors of this cavity, it sometimes becomes necessary for their complete eradication to remove the entire superior maxillary bone, and the following is the method pursued by Mr. Liston in the performance of this formidable operation:

The extent of the disease being accurately ascertained, the

points of separation are decided upon. Supposing the malar bone involved, the instruments employed are—a pair of straight tooth forceps, a full sized bistoury, copper spatula, powerful scissors, artery forceps, a small saw, and needles for interrupted and twisted sutures. He commences the operation by extracting a central incisor, either on the affected side or the opposite, as the size of the tumor may require. The point of the bistoury is then carried from the external angular process of the frontal bone through the cheek down to the corner of the mouth; the incision being guided by placing the fore and middle fingers in the cavity of the mouth. A second incision is made along the zygoma, connecting with the first. The knife is now pushed through the integument to the nasal process of the superior maxilla, detaching the ala from the bone, and cutting through the lip in the median line. The flap is dissected up and held by an assistant; the inferior oblique muscle, infra-orbital nerve, and other soft parts attached to the floor of the orbit, are cut, and supported by a narrow bent spatula.

The section of the bone comes next in order. This is made with the cutting forceps, dividing in succession the junction of the malar bone, the zygomatic arch, the nasal process of the superior maxilla, and then with strong scissors, after having notched the alveolar process, one blade is passed into the mouth, and the other into the nostril of the affected side, and the palatine arch is cut through. At this stage, the carotid artery is, if necessary, compressed. The tumor is now turned down from its bed, and the remaining attachments divided, preserving, if possible, the palatine plate of the palate bone with the velum palati. The branches of the internal maxillary artery being torn and stretched, may not require a ligature. The patient is now placed in a reclining posture, the cavity sponged out and examined, and all vessels that are seen, whether bleeding or not, are secured with a ligature, and the ends cut off. The space occupied by the tumor and removed structures are filled with lint, and the edges of the wound united with either the interrupted or twisted suture. No dressing is applied, plasters, bandages, etc., being thought useless. In twenty-four hours, some of the sutures are withdrawn, and plasters then applied; in forty-eight hours they are all removed, the wound by this time having adhered.

Other methods have been proposed for excision of the upper jaw. Ferguson begins his incision from the margin of the upper lip, carries it to the nostril, and along the ala to within half an inch of the inner canthus; a second incision extends from the angle of the mouth to the zygomatic process, and a third at right angles to this last, extending from the external angular process of the frontal bone toward the neck of the lower jaw. Gensoul lets fall a vertical incision from near the inner canthus, and divides the upper lip entirely through over the canine tooth; a tranverse cut, beginning on a level with the nostril, extends from this to the forepart of the lobe of the ear. A third incision, commencing about half an inch from the outer side of the external canthus, is carried down almost vertically, and touching the outer extremity of the transverse incision. Two flaps are thus formed, the one superior and dissected upward, the other inferior and turned downward.

Professor Warren and M. Velpeau use a single incision similar in shape, and extending from the external canthus, at its temporal margin, to the angle of the mouth. From this incision a flap is dissected upward from the surface of the bone, the ala detached from the nose, and the whole turned upward toward the forehead. From the same incision another flap is turned downward sufficiently to expose the malar and maxillary bones.

The use of the saw and cutting forceps, and, if necessary, the chisel and mallet, and the actual cautery, together with the securing of the arteries by ligature; in a word, the dressing of the wound in all these different ways is nearly the same as that already described.*

There are a number of highly interesting cases of sarcomatous, carcinomatous, and other tumors of the maxillary sinus, in Jourdain's Treatise on the Surgical Diseases of the Mouth; some of which we had intended to introduce into this book, but feared that it would extend it to too great a length. A number of equally interesting cases, reported in various other works,† are, for the same reason, excluded.

* Liston's Practical Surgery; Ferguson's Practical Surgery: Pancoast's Operative Surgery; Chelius' System of Surgery, and Druit's Surgeon's Vade Mecum.

† Journal de Chirurgie, tom. i; Parisian Chirurgical Journal, tom. i; Œuvres Chir. de Desault, par Bichat, tom. ii; New London Med. Jour. vol. i; Eichorn. Dis. de Polypis in antro Highmori. Trans. of the Society for the Improvement of Med. and

In conclusion, we would remark, that Professor Pattison proposed tying the carotid artery, in 1820, for the dispersion of fungous tumors of the maxillary sinus. He was induced to recommend this method of treatment from the consideration, that the capability of action of a part is proportioned to its vascularity, and that by thus cutting off the circulation of blood to it, the morbid growth would slough and be thrown off. He says this practice has been successful where it has been adopted in all the cases that had come to his knowledge.*

Surg. Knowledge. Recueil Periodique de la Soc. de Med., tom. ii; No. 9, Edinburgh Med. and Chir. Jour., Nos. 83 and 84; Traite des Maladies Chirurgieales, tom. iv; Traite des Maladies des Fosses Nasales; New York Jour. of Med. and Surgery; Western Lancet; Cooper's Surgical Dictionary; Benj. Bell's Surgery, vol. iv, &c.

* Appendix to Surgical Anatomy of the Head and Neck, pp. 477–8.

CHAPTER EIGHTH.

EXOSTOSIS OF THE OSSEOUS PARIETES OF THE MAXILLARY SINUS.

The osseous walls of the maxillary sinus somctimes become the seat of bony tumors—exostoses. This, however, is not an affection peculiar to the bony parietes of this cavity; all of the osseous structures of the body are liable to be attacked by it.

Exostosis, like many other diseases, presents several varieties. It is divided, by some writers, into true and false, the one consisting of a tumor composed wholly of bone, or nearly so, and the other, of a tumor composed both of ossific matter and fungous flesh, or of a mere thickening of the periosteal tissue.* Sir Astley Cooper divides exostosis into periosteal, medullary, cartilaginous and fungous. The first consists of a deposition of bony matter on "the external surface of a bone and the internal surface of its periosteum," and to both of which it firmly adheres. The second consists of "a similar formation, originating in the medullary membrane and cancellated structure of the bone," this description of exostosis never attacks the walls of the maxillary sinus. By cartilaginous exostosis he means, "that which is preceded by the formation of cartilage, which forms the nidus for the ossific deposit." Fungous exostosis he describes to be a tumor not so firm in its consistence as cartilage, but harder than fungous flesh, having interspersed through its substances spiculæ of bone; it has a malignant character, and is dependent upon some peculiar constitutional diathesis. This species of exostosis differs but little, if at all, from osteo-sarcoma.

Exostoses differ as much in shape as they do in structure. They sometimes rise abruptly from the surface of bones by a narrow and circumscribed base, projecting in large irregularly or spherically shaped masses; at other times they rise very gradually, covering a larger surface of the affected bone, but less

* Dictionaire des Sciences Medicales, t. xvi, p. 218.

prominent and with outlines less perfectly defined. An exostosis has been known to occupy the whole extent of the surface of a bone. "The whole external surface of one of the bones of the skull was found occupied by an exostosis, while the cerebral surface of the same bone was in a natural state.* Both sides and the whole thickness of bones are occasionally affected by this disease. This is what Sir Astley Cooper calls periosteal exostosis.

This disease is said to attack some bones more frequently than others. Those of the skull, the lower jaw, sternum, humerus, radius, ulna, femur, tibia and bones of the carpus are the most subject to it. It also very frequently attacks the upper jaw; in fact, none of the bones of the body are altogether exempt from it.

The texture of exostosis is sometimes spongy and cellular, at other times, very dense. Dr. E. Carmichael, a distinguished surgeon and physician, formerly of Fredericksburg, described to the writer, a few years since, an exostosis of the superior maxilla, which had, a short time before, fallen under his observation, larger than a hen's egg, and as solid as ivory. Exostosis of the roots of the teeth is always hard, and instances are sometimes met with of osseous tumors upon other bones possessed of nearly an equal degree of solidity. Exostoses of this description grow less rapidly than those which are more cellular; but they sometimes acquire a very large size. It is not, however, uncommon for such, after having attained a greater or less size, to cease to grow, and "remain stationary" through life, without giving rise to any very serious or unpleasant consequences.

Exostoses sometimes attain an enormous size, and especially upon cylindrical bones; very large ones, too, are frequently met with upon the maxillæ. The largest one, we believe, of the maxillary sinus, of which medical history furnishes any account, is exhibited upon a specimen of morbid anatomy, presented, in 1767, by M. Beaupreau, to the French Academy. A description and drawing of this tumor is contained in the Memoirs of the Royal Academy of Surgery, but we have no account of the history of its formation, nor of the symptoms attending it. The tumor occupies the whole of the right maxillary sinus, and several of the neighboring bones are involved in it. It is very

* American edition of Cooper's Surgical Dictionary, p. 362.

large near its base, and projects from the lower part of the orbit, forward and downward, six inches. Its largest circumference is about twelve inches. The upper part of the maxillary bone, says Bordenave, projects on the side of the orbit, and straightens the cavity; the *os unguis* is included in the mass of the tumor, and is represented as being nearly effaced. The nasal bones of the left side are displaced, and the right nostril entirely closed up, and the exostosis projects so much on the left side as to be nearly underneath the malar bone. The inferior part of the maxillary bone, says our author, is so extended near its base, that it inclines obliquely to the left, and the pterygoid apophyses of this side are larger than those of the other. The malar bone is described as being involved in the upper and external part of the exostosis, which extends to the left maxillary bone.

Externally, says Bordenave, the tumor had a smooth and polished appearance; its upper part was very hard; below, its substance had become thinner, was deficient in some places, and the interior of the exostosis was exposed. The substance of the bone was spongy and porous, and, in appearance, not unlike pumice-stone. The walls were thick, and measured, in some places, one inch.*

From this brief description, taken from an account given by Bordenave, some idea may be formed of the dimensions and appearance of this enormous and most remarkable exostosis.

A case of exostosis of each antrum is described by Sir Astley Cooper, both of which forced themselves up into the orbits, and pushed the eyes from their sockets. One made its way into the brain, and caused the death of the patient.†

Mr. Thomas Bell does not believe in the occurrence of "true exostosis upon the bony parietes" of this cavity, but too many examples have presented themselves, to leave any room for doubt upon the subject. Although none may ever have fallen under his own immediate observation, there are many well authenticated cases on record; but, apart from these, we think it would be difficult to assign any sound reasons for supposing that the osseous walls of this cavity should be more exempt from the disease than other bones of the body.

* Memoires de l' Academie Royale de Chirurg., t. xiii, obs. xii, p. 412.

† Surgical Essays, part i, p. 157.

SYMPTOMS.

Exostosis of the walls of the maxillary sinus is generally so insidious, that the presence of the disease is not, for a long time, even suspected. When it results from venereal vice, Boyer says, it is preceded by acute pain, extending at first to almost every part of the bone, but afterward confining itself to the affected portion. When it is occasioned by scrofula, the same writer tells us, it is attended by a duller and less severe pain; the symptoms of exostosis resulting from causes purely local—such, for example, as a blow—are very similar.* These signs are common to the disease wherever it may be situated, and when it is seated in the maxillary sinus, they do not distinguish it from many of the other affections that occur here. Furthermore, the disease not unfrequently gives rise to symptoms attendant upon several of the other affections of this cavity, so that, previously to the distension of its walls, it may be confounded with inflammation of the lining membrane, or with sarcomatous or other tumors. After it has filled the sinus, or very considerably thickened its exterior walls, it will cause them to offer a firmer resistance to pressure than any of the other diseases of this cavity. When, therefore, they have become distended, if they are firm and unyielding to pressure, the presence of exostosis may be inferred.

CAUSES.

There is a difference of opinion among writers on the diseases of bones, with regard to the causes of exostosis. Certain constitutional diseases, such as "scrofula and lues venerea," are thought by some to give rise to the affection. That the last of these diseases is favorable to its production, is we believe, admitted by all; but Sir Astley Cooper declares that no evidence has yet been adduced to prove that the former is ever concerned in its production. Others impute the disease to local irritation produced by contusions, fractures, &c. It is probably dependent upon both local and constitutional causes, neither being capable, independently of the other, of producing it.

* Traité des Maladies Chirurgicales, t. iii, p. 545.

TREATMENT.

A variety of plans has been recommended for the treatment of this disease; and Bordenave assures us it may be cured, if suitable remedies are applied before it has acquired much solidity. Assuming that it sometimes results from constitutional causes, he directs that the treatment should be commenced by the employment of such means as are indicated by the nature of the vice with which the patient may be affected. If a venereal vice be present, the use of mercurial medicines are recommended. The author last mentioned says, he has known it to be successfully treated with mercury. Topical applications, such as fomentations and cataplasms, have also been found serviceable. Boyer advises poultices of linseed meal, and a decoction of the "leaves of henbane and nightshade." Iodine and mercury have been employed, but not, we believe, with any decided advantage. Sir Astley Cooper thinks the best internal remedy is "oxymuriate of mercury, together with the compound decoction of sarsaparilla." We believe, with Boyer, that a dispersion of an exostosis can never be effected. Its progress may, perhaps, be partially arrested, but we do not believe that it is ever taken up by the absorbents. It is not advisable to remove an exostosis, unless it continues to augment and is likely to become dangerous, or is productive of serious inconvenience.

When the remedies which have been mentioned, after having been thoroughly tried, prove unsuccessful, and it becomes necessary to remove the exostosis, the tumor should be fully exposed; first, by the dissection of the gum and other soft parts from the exterior walls of the sinus, and, second, by the perforation of this cavity with a trephine, or such other instrument as can be most conveniently employed. This part of the operation, though simple, should be conducted with care. If the tumor is large and attached by a very broad base, its removal will sometimes prove more difficult; yet by means of suitably constructed saws, scissors, knives, &c., it may, in most instances, be accomplished. An external wound through the cheek should always, if possible, be avoided.

The method of operating, however, will be best understood

by a description of that pursued in the two following cases. The first was treated by Dr. B. A. Rodrigues, dentist, of Charleston, S. C., and reported by him for the American Journal of Medical Sciences.

Case 21st. "On the 14th of August, 1837, Charity, a servant woman of Mrs. Miller, called on me to ascertain whether I could afford her any relief in her wretched condition. She had been laboring under incessant and agonizing pain in the antrum highmorianum of the right side, which she regarded as the consequence of the impaired condition of the teeth. On this supposition, she had several of them extracted, without any appreciable abatement of her sufferings. Yet, deluded with the belief that some one of the remaining teeth was the secret agent of all she suffered, she persisted in having more extracted. Still, the evil continued, the suffering was unabated, the cause undetected; and to add to the depression of her hopes, and the aggravation of her ills, a purulent discharge oozed from the empty sockets of the affected side. She again had recourse to medical advice, hoping that this phasis of her malady might lead to some indications that would relieve her; at least, that it might reveal its hidden sources, its condition, and its prospect of being remediable. And here, for the first time, was it suggested that the antrum was in an unsound state.

"It was at this moment, under these circumstances, that she applied to me to perform an operation, which her medical adviser declared to be indispensable. At first, I imagined it to be an abscess from which the pus was discharged, because of the strange sensations experienced, and the greater frequency of this disease over others peculiar to this part. I inserted a trocar into the socket of the second molar, and instead of the gush of matter I had expected, the passage of the instrument was intercepted by a hard, dense, impervious substance. The existence of an exostosis now forced itself on me. To make assurance doubly sure, I had access to several of my medical friends, among whom was Dr. Geddings. On examination of the part, the consideration of the symptoms, and the obstinate nature of the disease, they concurred with me in opinion, that an exostosis was present, and that the sole indication of relief was its extirpation. Accordingly, on the 18th of August, these gentlemen, with several others

of the profession, were present when I proceeded to perform the operation. With a common scalpel, I dissected away the gum from the canine tooth to the last molar, raised the flap which it made from the alveolar process, and with a trephine opened into the cavity. Success was easier than had been anticipated, in consequence of the carious condition of the bone, which was so general on the affected side, as to reach from the second incisor anteriorly to the pterygoid process posteriorly. The external parietes of the cavity shared in the loss of substance, so that the bony tumor which filled up and occupied it, could be readily reached. The trephine was applied, the cavity enlarged, and the exostosis removed. It measured in circumference three inches, was light, and cancelated on its surface, but dense and more resisting in its internal layers. There was little or no hemorrhage to delay the operation, or any application necessary to arrest it. After removing every spiculum of diseased bone, and cleansing out the cavity, the flap was replaced, and the cure was entrusted to nature. Granulations sprouted up in full luxuriance, and in the short period of four weeks, the woman was in the enjoyment of excellent health."*

That the foregoing was a case of true exostosis of the maxillary sinus, does not admit of doubt; and it is to be regretted, that there is not more of the early history of the disease, and the circumstances connected with its development. They might, perhaps, lead to a correct explanation of the causes that gave rise to it. The presence of local irritants in the immediate vicinity of this cavity, is proven by the fact that the patient's teeth were in a diseased condition; but to what extent they may have contributed to the production of exostosis it is impossible to determine, since we are not furnished with any information concerning the state of her general health. She may have been affected with some constitutional vice, or peculiar habit of body, whereby the osseous structures of the system were predisposed to affections of this description; requiring only the presence of some local irritant to induce the morbid action necessary to their development. If all the circumstances connected with the previous history of the case could be ascertained, they would, we believe, show that such predisposition did exist, and that such

* American Journal of Medical Science.

action was excited by the irritation produeed by the diseased teeth.

When the exostosis is so situated as to prevent its complete removal, the applieation of the aetual cautery to any remaining portions will prove serviceable, by causing such parts to exfoliate. The history of a case is related by M. Bordenave, as treated by M. Runge, in which a portion of the extostois was left, and whieh ultimately caused the death of the patient. This would probably have been prevented, had an exfoliation of the remaining diseased portion of bone been brought about by an applieation of the aetual eautery.

Case 22d.* The subject of this case was a man 33 years of age. He had been for a long time afflieted with a tumor in the region of the right antrum. It depressed the palatine process of the maxillary bone and the palate bone of the affeeted side in such a manner as to restrict the movements of the tongue, while on the other side it pressed against the floor of the orbit so as to cause a protrusion of the eye. Anteriorly, it had elevated a portion of the maxillary and malar bones whieh covered it, and extended to the most dependent part of the nose, extending backward as far as the posterior mouth: it also exerted similar pressure and displaeement in a lateral direction.

After having exposed the anterior parietes of the antrum, M. David could see the uppermost part of the projection of the tumor, which was of a spherical shape, and nearly three inches in diameter; and, after having elevated this part, he diseovered the tumor, which was white and hard, although spongy, and occupied the whole cavity, changing its form and inereasing its dimensions to an extraordinary degree. The greater portion of this hard osseous substanee, although firmly adhering to almost every part of its bony envelope, was detached by a persevering employment of various means, such as the erotehet, elevator, surgeon's rasp, ete. In doing this, he inflieted some injury upon the floor of the orbit; and to some portions of exostosis whieh still adhered to the palatine proeess of the maxillary bone, he several times applied the aetual cautery.

An opening was formed by this operation four and a half inehes deep, and from right to left more than three inches; but

* Memoires de l'Academie Royale de Chirurg., t. xiii., obs. xi., p. 408.

the use of the cautery speedily effected a cure, which would not perhaps have been otherwise successful.

Exostosis of the maxillary sinus often gives rise to other morbid conditions of this cavity, the remedial indications of which should be properly attended to, as should also those of any constitutional affection, vice, or habit of body that the patient may be laboring under at the time. When, however, the exostosis is not complicated with any other disease of the cavity, the restorative energies of nature will generally be all that is required, after its removal, to complete the cure.

CHAPTER NINTH.

WOUNDS OF THE OSSEOUS PARIETES OF THE MAXILLARY SINUS.

The walls of the maxillary sinus are sometimes fractured by blows and pierced by sharp-pointed instruments. Fauchard mentions a case, in which a canine tooth had been driven up into it.* This is an accident that rarely happens. The instance here alluded to, is, we believe, the only one on record; and, as might be supposed, it was followed by severe pain, and ultimately gave rise to a tumor upon the cheek near the nose, with three fistulous openings, from which fetid matter was discharged. The sinus having been opened, and the tooth taken from it, a cure was at once effected.

It often happens that, when the walls of the sinus are fractured by a blow or other mechanical violence, portions of the bone and foreign bodies are driven into the cavity; these, remaining there, become a constant source of irritation to the lining membrane, and, not unfrequently, a hidden cause of other and more malignant forms of disease. Bordenave describes the case of a French officer, who had the walls of the maxillary sinus fractured by a fragment of a bomb-shell. Dressings were applied to the wound, but it did not heal; upon examination sometime after by M. Allouel, several pieces of bone and a splinter which nearly filled the cavity were found. These were removed, but a cure was not immediately effected; a fistulous opening still remained, and it was not until a long time after, when another splinter came away, that the external opening healed. The same writer mentions the case of a man who had a nail forced head foremost, by the discharge of a gun, into his right cheek and maxillary sinus. The opening became fistulous, and although the point of the nail was subsequently discharged, it was not until M. Faubert had removed the remaining part, that the fistula closed.

* Le Chirurgien Dentiste, tom. i, page 391.

Contused wounds of the antrum are often complicated with fracture of the osseous parietes; so that the effects resulting from them are more to be dreaded than those which would be produced simply by the penetration of a sharp instrument.

TREATMENT.

The nature and extent of the injury inflicted, should determine the treatment most proper to be adopted for wounds of this cavity. Complicated as they in most instances are by the presence of extraneous substances, the removal of these constitutes the first, and not unfrequently, the only remedial indication; therefore when any extraneous bodies, or portions of bone, have been forced into the sinus, they should all be carefully removed. The external wound may next be dressed with adhesive slips to prevent the formation of an unsightly cicatrix. If constitutional symptoms supervene, they should be met with appropriate remedies.

The following interesting case of a wound of the maxillary sinus, inflicted with a dirk-knife, treated by W. H. Donne, M.D., of Louisville, Ky., is taken from the "Western Journal of Medicine and Surgery:"

Case 23d. "Schuti, a gardener, aged forty-two years, a native of Germany, in a rencontre with an athletic man, on the 3d of May, 1840, was struck with a dirk-knife, which entered about an inch above the right superciliary arch, passed through the corresponding eyelid downward and backward, evacuating the humors of the eye, and penetrating the antrum. The globe of the eye was divided by a vertical incision, through which the aqueous humor escaped; the iris was extensively detached at the ciliary margin, and could be partially seen through the transparent cornea, its surface being somewhat obscured by small coagula. The hemorrhage was slight and easily controlled by moderate pressure. The patient complained of intense pain in the temple and cheek of the wounded side shooting far into the orbit. Three points of interrupted suture were used to approximate the edges of the divided eye. Lint, saturated with laudanum and warm water, constituted the dressing.

"May 4th. Some tumefaction in the eyelid; pulse 110; tongue

coated and dry; skin hot; patient had spent a very restless night. Ordered following medicine: tart. emetic, gr. i.; sulph. magnesiæ, ℥ss.; to be dissolved in one-half pint of water, and a table-spoonful to be taken every half-hour, until nausea is induced; after which the interval may be increased.

"May 5th. Bowels freely evacuated; pain less; skin moist; pulse 90 and soft. From this period until the wound healed—a space of three weeks—no constitutional symptoms of an untoward character occurred. The patient, however, contended that a portion of the knife-blade remained in the roof of his mouth. But, on the most careful examination, no foreign body could be detected.

"On the 10th of August, 1842, Mr. Schuti called and requested Dr. Donne to examine his mouth, stating that for six months past he had been annoyed by a rough, projecting substance, which, some person had informed him, was a piece of dead bone, but which he believed to be the point of the knife, that had been driven down into the bone by the violence of the blow. On looking into the mouth, a small black speck was discernible about one-half inch from the interval between the first and second molar teeth. The parts adjacent were somewhat tumefied and inflamed. Dr. Donne made several attempts to extract this body with a pair of common dissecting forceps, but found it immovably fixed in the substance of the bone. By dissecting around it with a bistoury, down to the palate process of the superior maxillary bone, he was enabled to get a firmer hold, and, with a pair of curved tooth-forceps, succeeded in removing a fragment of the blade, one and one-fourth inches in length and three-fourths in width at the widest part; the extraction was not effected without considerable violence, and was attended with extreme suffering. The fragment came out with an audible snap, which induced those present to suppose, at first, that it had been broken; but, on inspecting its surface closely, no evidence of recent fracture could be seen. Upon probing the aperture through which the fragment had been extracted, no other piece could be detected. This opening would scarcely admit the curved probe, which Dr. Donne passed into the antrum, in order to satisfy himself that the whole of the foreign body was removed. The next day there was a slight discharge from

the aperture, though the patient has suffered very little pain since the operation."

The foregoing is certainly one of the most singular cases of which we have any account, and the most remarkable circumstance connected with it is, that no more injury should have resulted from the presence, for so long a time, in the maxillary sinus, of the fragment of the dirk. In the cases previously noticed, as reported by Bordenave, disease of the mucous membrane of the antrum and the discharge of fetid sanies resulted from the presence of the foreign bodies in this cavity. The same effect was also produced in the case described by Fauchard, where the canine tooth had been forced up into the antrum.

CHAPTER TENTH.

FOREIGN BODIES IN THE MAXILLARY SINUS.

That foreign bodies are sometimes admitted into the maxillary sinus through wounds penetrating its exterior parietes, has already been shown, but that they should gain access to it in any other way, would seem almost impossible. The smallness and peculiar situation of the nasal opening which communicates with it, one might think, would preclude the introduction of extraneous substances of any kind through it; yet they have been found here when they could have gained admission in no other way. There are several well authenticated cases on record in which worms have been found in this cavity. But the case mentioned by Bordenave, in the Memoirs of the Royal Academy, of a diseased maxillary sinus, from which several worms were at different times discharged, does not prove that they obtained admission into it through the nasal opening; for in this case, a fistulous opening from the cavity had existed for a long time previously to the discharge of the worms, and it is very probable that they introduced themselves through this opening. A cause sufficient to have produced the disease in the sinus had been operating for two years, immediately preceding its manifestation, the patient, during the whole of this time, having been affected with pain in the superior teeth of the affected side.

Deschamps, says his colleague in la Charité Hospital, found a worm four inches long in the maxillary sinus of a soldier, whom he was dissecting; and the same writer informs us that a similar example is furnished in the Journal of Medicine. The particulars of a case which came under the observation of Mr. Heysham, physician, of Carlisle, England, are contained in Cooper's Surgical Dictionary. The subject of this case was a strong woman, sixty years of age, who was in the habit of taking a great deal of snuff. She was affected for a number of years with severe pain in the region of the maxillary sinus, which ex-

tended over one side of the head. She was never entirely free from this pain, but it was greater in cold than in warm weather. For the purpose of obtaining relief, she had been twice salivated, and had taken various anodyne medicines; the pain, however, instead of being mitigated by these means, became more severe, Her teeth on the affected side were all extracted, and as a last resort the maxillary sinus was perforated. This for several days did not give any relief. Injections of bark and "elixir of aloes," were thrown into it, and on the fifth day a dead insect, more than an inch in length and as thick as a goose quill, was removed from this cavity.

Instances of the introduction of insects or foreign bodies of any description into the antrum, through the nasal opening, fortunately, are so exceedingly rare, that the Memoirs of Medicine do not furnish more than four or five well established examples. The great annoyance and distress which their presence in the nasal and communicating cavities may occasion, proves the "wisdom of design" in the growth of hairs found just inside the nostrils. Were it not for these, as this aperture is, unlike the mouth, permanently open, insects might pass in during the unguarded hours of sleep.

The signs indicative of the presence of insects or foreign bodies in the maxillary sinus, are so obscure, that the fact can only be ascertained by perforating the cavity and by examination of its interior. Some say that foreign bodies here cause an itching, crawling or tickling sensation in the substance of the cheek. This is an uncertain diagnosis, for such sensations are not unfrequent in the region of this cavity. That they sometimes cause great pain, is proven by the history of the case related by Mr. Heysham, the particulars of which we have just noticed. The proper remedial indication for foreign bodies in the antrum, is their removal. When insects are discovered here, injections of oil and tepid water are recommended. This constitutes all the treatment necessary to be employed in cases of this kind.

PART SIXTH.

MECHANICAL DENTISTRY.

PART SIXTH.

MECHANICAL DENTISTRY.

By mechanical dentistry is meant the art of constructing and adapting—1. Appliances for the correction of Irregularity in the arrangement of the natural teeth; 2. Artificial Teeth; 3. Artificial Palates. As the various (1) appliances employed for the correction of irregularity of the teeth have already been described, it will not be necessary to refer to the subject again. In treating upon this part of our subject, we shall, for the present, confine ourself to the description of the various methods of constructing and applying (2) artificial teeth, reserving what we may have to say upon (3) artificial obturators and palates for the seventh and last part of our work.

Before entering upon a description of the method of procedure in the construction of artificial substitutes for the natural teeth, and the manipulations connected therewith, we shall offer a few general remarks on the subject of such substitutes—the substances of which they are composed; the means employed for their retention in the mouth; and the surgical treatment required preparatory to their application.

CHAPTER FIRST.

ARTIFICIAL TEETH.

Contributing as the teeth do to the beauty and expression of the countenance; to correct enunciation; and, through the improved facility of mastication, to the health of the whole organism—it is not surprising that their loss should be considered a serious affliction, and that art should be called upon to replace such loss with artificial substitutes. So great, indeed, is the liability of the human teeth to decay, and so much neglected are the means of their preservation, that few persons, at the present day, reach even adult age without losing one or more of these invaluable organs. Happily for suffering humanity, they can now be replaced with artificial substitutes so closely resembling the natural organs, as to be readily mistaken for them, even by critical and practiced observers. Although there is a perfection in the work of nature that can never be equaled by art, artificial teeth are now so constructed as to subserve, at least to a great extent, the purposes of the natural organs. When properly adjusted, they are worn without the slightest discomfort; so much so, in many cases, that the patient, after they have been in the mouth a few days, is scarcely conscious of their presence.

The construction and insertion of artificial teeth is an operation which, though acknowledged to be of great importance, and performed by every one having any pretension to a knowledge of dentistry, is, unfortunately, but little understood by the majority of practitioners. The mouth is often irreparably injured by their improper application. A single artificial tooth, badly inserted, may cause the destruction of the two adjacent natural teeth, or those to which the artificial appliance is secured; and if the deficiency thus occasioned be unskillfully supplied, it may cause the loss of two more; in this way all the teeth of the upper jaw are sometimes destroyed.

The utility of artificial teeth depends upon their being properly constructed, and correctly applied. Nor is there any branch of dental practice that requires more skill and judgment, or more extensive and varied scientific information. A knowledge of the anatomy and physiology of the mouth, of its various pathological conditions, and of its therapeutical indications is as essential to the mechanical as to the operative dentist; moreover to correct information upon these subjects, must be superadded ability to execute with the nicest skill and most perfect accuracy, the various pieces of mechanism required in dental prosthesis.

There are difficulties connected with the insertion of artificial teeth which none but an experienced dentist has any idea of. They must be constructed and applied in such a manner, that they may be easily removed and replaced by the patient; at the same time they must be securely fixed in the mouth, and productive of no injury to the parts with which they are in relation. But there are sometimes others equally difficult to overcome, for example: the loss of a tooth in one jaw, is generally followed by the gradual protrusion of its antagonist from the socket; so that if the loss of the former be replaced with a substitute of equal size, it will often strike against the latter at each occlusion of the mouth, and prevent the other teeth from coming together. This tendency of the teeth in one jaw to protrude, is always in proportion to the number lost in the other; and if not soon counteracted by the replacement of the latter with artificial substitutes, it often gives rise to difficulties in their proper application, requiring no little ingenuity and tact to overcome.

Notwithstanding the triumphs of Mechanical Dentistry, and the high state of excellence to which it has arrived, at no previous time was there ever so much injury inflicted, and suffering occasioned by artificial teeth, as at present—resulting solely from their bad construction and incorrect application. That such should be the case, when there are so many scientific and skillful dentists in every city, and in many of the villages of the country, may seem strange, but the fact is nevertheless undeniable. We may explain it in part by the very rapidly increasing demand for dental services, which has not allowed time for the development of intelligent and skilled labor either of head or hand; in part also by the universal experience that all new professions

are full of immature and crude material. But these explanations cannot long be received in excuse for a state of things which ought to be rapidly disappearing—which is in fact giving way under the combined influence of our colleges, our periodicals and text-books, the teachings and example of our eminent practitioners and the more appreciative judgment of the public.

The information obtainable from works on mechanical dentistry, was until recently exceedingly limited; and it is surprising, that from the number who have written on the diseases and loss of the teeth, this subject should have received so little attention. Fauchard, Bourdet, Angermann, Maury, Delabarre, Koecker, Lefoulon, Brown and a few others, were all who had given it anything more than a passing notice; and the works of but few of these writers contain anything like explicit directions upon the subject. Delabarre's Mechanical Dentistry was, at the time of its publication, a work of much merit. The various methods adopted at that period, for the construction and application of artificial teeth, are accurately and minutely described, together with the advantages and disadvantages of each. But, however perfect the work may then have been, it does not furnish the information required upon the subject at the present day. And still more deficient in correct information are nearly all the other French works.

Among the English writers, Koecker is almost the only one, except Robinson, a more recent author, who has described correctly the principles upon which artificial teeth should be applied. His "Essay on Artificial Teeth, Obturators and Palates," contains much useful and valuable information. It does not, however, contain a description of the manner of constructing a dental substitute, preparatory to its application; yet, to one capable of executing the various manipulations required in this department of practice, it is very serviceable. Dr. Koecker, perhaps, thought that as this ability can only be acquired by a regular apprenticeship, a more minute description was unnecessary. There are many practitioners, however, who, although in other respects competent, have not, in the mechanical department, enjoyed this advantage, and, consequently, it is to be regretted, that he has not entered more into detail upon the subject. But most of the deficiencies that exist in the last named work,

were supplied up to 1844, by Dr. Solyman Brown, in his series of papers on Mechanical Dentistry, published in the American Journal of Dental Science. These papers were illustrated with numerous cuts, and constituted the best treatise upon the subject that had appeared up to the time of their publication. But numerous and important improvements have subsequently been made in this department of practice, all of which we propose to give a brief description of in their proper place.

The only treatises upon Mechanical Dentistry, published in book form, in this country, since the papers of Dr. Brown, have been this Division of our own work and the Treatise of Professor G. Richardson. In the dental periodicals of the past twelve years will be found many carefully prepared papers from the pen of Professor Austen. These journals elsewhere offer a vast amount of information, very valuable to the practitioner who has the ability to select with judgment. They give also an instructive view of the rapid progress made in dental art, and teach the necessity of being constantly alive to the improvements, real or fancied, which are almost daily proposed.

We shall enumerate some of the different kinds of dental substitutes that have been employed since the commencement of the present century. We shall also notice briefly, the principal methods that have been adopted in their application, before entering upon a minute description of those practiced at the present time. Great improvements have been made in dental prosthesis since the publication of the first edition of this work. In fact no science or art, except Chemistry, has been so eminently progressive during the last twenty years as Mechanical Dentistry.

CHAPTER SECOND.

SUBSTANCES EMPLOYED AS DENTAL SUBSTITUTES.

There are two qualities which it is highly important that dental substitutes should possess. They should be durable in their nature; and in their appearance should resemble the natural organs which they replace, or with which they have often to be associated.

The kinds of teeth that have been employed, since 1830, are:

1. Human teeth.
2. Teeth of neat cattle, sheep, &c.
3. Teeth carved from the ivory of the elephant's tusk, and from the tooth of the hippopotamus.
4. Porcelain teeth, called also indestructible teeth.

HUMAN TEETH.

As regards appearance, which in a dental substitute is an important consideration, human teeth are preferable to any other; when used for this purpose, they should be of the same class as those, the loss of which they are to replace. The crowns only are employed, and if well selected, and skillfully adjusted, the artificial connection with the alveolar ridge cannot easily be detected.

The durability of these teeth when thus employed, depends upon the density of their texture, the soundness of their enamel, and the condition of the mouth in which they are placed. If they are of a dense texture, with sound and perfect enamel, and are placed in a healthy mouth, they will last from eight to twelve years or even longer. The difficulty, however, of procuring these teeth, is generally so great, that it is seldom that such as we have described, can be obtained; and even when they can, the mouth in half the cases in which artificial teeth are placed, is not in a healthy condition; its secretions are often so vitiated and of so corrosive a nature, that they destroy them in less than four years. We have even known them to be destroyed by caries in two, and in one case in fifteen months.

A human tooth, artificially applied, is more liable to decay than one of equal density having a vital connection with the general system, for the reason, that its dentinal structure is more exposed to the action of deleterious chemical agents. Yet of all the animal substances employed for this purpose, human teeth are unquestionably the best. They are harder than bone, and being more perfectly protected by enamel, are consequently more capable of resisting the action of corrosive agents.

Many object to having human teeth placed in their mouth, under the belief that infectious diseases may be communicated by them. There is no good foundation for such fear, because the purifying process to which they are previously submitted, precludes the possibility of the communication of disease. When the practice of transplanting teeth was in vogue, occurrences of this sort were not unfrequent; but since that has been discontinued, these have never happened. Still, the prejudices of some against human teeth are so strong, that it is impossible to overcome them. This feeling, the difficulty of procuring them, the high price they command, and their want of durability have gradually led to their entire disuse: which is scarcely to be regretted, now that art can produce in porcelain such accurate imitations of nature. The only cases in which we might feel called upon to insert natural teeth is when any of the twelve front teeth become loosened from periosteal disease and drop from their sockets while yet perfectly free from caries. These teeth themselves may often be adjusted to a plate so as to present an exceedingly natural appearance.

TEETH OF CATTLE.

Of the various kinds of natural teeth employed for dental substitutes, those of neat cattle, are, perhaps, after human teeth, the best. By slightly altering their shape, they may be made to resemble the incisors of some persons; but a configuration similar to the cuspids cannot be given to them, and in a majority of cases they are too white and glossy to match very closely the human teeth. The contrast, therefore, which they form with the natural organs should constitute, were they in all other respects suitable, a very serious objection to their use. This imitation of nature has been too much disregarded, both by dentists

and patients. Indeed, many of those who need artificial teeth, wish to have them as white and brilliant as possible, and the practitioner lacks either the decision or the judgment to refuse compliance with a practice, which destroys all that beauty and fitness which it is the aim of dental æsthetics to cultivate.

But there are other objections to the use of these teeth. In the first place they are only covered anteriorly with enamel; in the second, their dentinal structure is less dense than that of human teeth, and consequently they are more easily acted on by chemical agents. They are, therefore, less durable, seldom lasting more than from two to four years. Another objection to their use is, they can be employed in only the very few cases where short teeth are required, owing to the large size of their nerve cavities. If cut down to the proper size artificially, these cavities are apt to be exposed; and if filled up by ossific deposit while in the mouth of the animal, they are by that time worn down too short to be of use except when very short teeth are required. It is seldom, therefore, that they can be advantageously used as substitutes for human teeth.

IVORY OF THE ELEPHANT AND HIPPOPOTAMUS.

Artificial teeth made from the ivory of the tusk both of the elephant and hippopotamus have been sanctioned by usage from the earliest periods of the existence of this branch of the art. We must not hence conclude that it has been approved by experience; on the contrary, of all the substances that have been used for this purpose, this is certainly the most objectionable.

The ivory of the elephant's tusk is decidedly more permeable than that obtained from the hippopotamus. So readily does it absorb the buccal fluids that, in three or four hours after being placed in the mouth, it becomes completely saturated with them. Consequently, it is not only liable to chemical changes, but the absorbed secretions undergo decomposition; and when several teeth, formed from it, are worn, they affect the breath to such a degree as to render it exceedingly offensive. Again on account of its softness, teeth are easily shaped from it; but not being covered with enamel, they soon become dark, and give to the mouth a repulsive appearance. Fortunately, however, in the

United States, elephant's ivory is rarely used, either as a basis for teeth or for the teeth themselves.

The ivory of the tusk of the hippopotamus is much firmer in its texture than that obtained from the elephant; being covered with a hard, thick enamel, teeth may be cut from it, which, at first, very closely resemble the natural organs. There is, however, a peculiar *animation* about human teeth, which those made from this substance do not possess: moreover they soon change their color, assuming first a yellow and then a dingy bluish hue. They are, also, like elephant ivory, very liable to decay. We have in our possession a number of blocks of this sort, some of which are nearly half destroyed.

But the same objection lies against teeth made from the hippopotamus ivory, which, even were there no other, would be sufficient to condemn its use. Like those formed from elephant ivory, they give to the air returned from the lungs, an offensive odor, which cannot be corrected or prevented. They may be washed half a dozen times a day, and taken out and cleansed again at night, but it will still be perceptible; and, although it may be worse in some mouths than others, no one who wears teeth made of this substance can be entirely free from it.

PORCELAIN OR INCORRUPTIBLE TEETH.

The manufacture of porcelain teeth did not for a long time promise to be of much advantage to dentistry. But by the ingenuity and indefatigable exertions of a few, they have within the last thirty years, been brought to such perfection as almost to supersede any other kind of artificial teeth.

The French, with whom the invention of these teeth originated, encouraged their manufacture by favorable notices; and the rewards offered by some of the learned and scientific societies of Paris contributed much to bring it to perfection. They were still, however, deficient in so many particulars, that they received the approbation of very few of the profession, and then only in some special cases. It is principally to American dentists that we are indebted for that which the French so long labored in vain to accomplish.

A want of resemblance to the natural organs, in color, translucency, and animation, was the great objection urged against

porcelain teeth; and, had not this been obviated, it would have constituted an insuperable objection to their use. Until 1833, all that were manufactured had a dead opaque appearance, which rendered them easy of detection, when placed alongside of the natural teeth, and gave to the mouth a sickly aspect. But so great have been the improvements in their manufacture, that few can now distinguish any very marked difference between them and the natural teeth.

The advantages which mineral teeth possess over every sort of animal substance, are numerous. They can be more readily secured to the plate, and are worn with greater convenience. They do not absorb the secretions, and, consequently, when proper attention is paid to their cleanliness, they do not contaminate the breath, or become in any way offensive. Their color never changes. They are not acted on by the chemical agents found in the mouth, and hence the name *incorruptible*, which has been given them.

The objections that have been urged to the use of porcelain teeth—such as, want of congeniality between them and the mouth, their better conducting power, and their consequent greater liability to the action of heat and cold—have so little foundation, that, when compared with the advantages they confessedly possess, they must be regarded as unworthy of consideration. The vast extension of mechanical practice is due, more than to any other one cause, to these improvements in the manufacture of porcelain teeth,—improvements essentially *American*, and so important as fairly to justify a little of that boasting spirit which, transplanted from the mother country, has attained such luxuriant growth in American soil.

The beautifully exact imitation of the varying shades of the natural gum, which as yet has been found possible only in porcelain, would of itself give to this material a claim over every other. All attempts to color ivory have failed to produce any permanent results. More recent experiments in the several vulcanizable materials have thus far given opaque and lifeless colors, which no stretch of the imagination can compare with the natural gum. When a material shall have been discovered possessing the valuable properties of the vulcanite, combined with the beauty of a porcelain artificial gum, dental prosthesis will have nearly reached perfection.

CHAPTER THIRD.

DIFFERENT METHODS OF INSERTING ARTIFICIAL TEETH.

The methods of retaining artificial teeth in place are—*first*, by pivoting to the natural roots; *second*, by attaching to metallic or other kind of base-plate, secured either by, 1, clasps, 2, spiral springs, or 3, atmospheric pressure. The peculiar advantages of each of these methods we shall now proceed to point out, and the cases to which they are particularly applicable.

ARTIFICIAL TEETH PLACED ON NATURAL ROOTS.

This method of securing artificial teeth, was, until recently, on account of its simplicity, more extensively practiced than any other; and, under favorable circumstances, is, unquestionably, one of the best that can be adopted. If the roots on which they are placed be sound and healthy, and the back part of the jaws supplied with natural teeth, so as to prevent those with which the artificial antagonize from striking them too directly, they will subserve the purposes of the natural organs more perfectly than any other description of dental substitute, and can be made to present an appearance so natural as to escape detection upon the closest scrutiny. If properly fitted and secured, not only is their connection with the natural roots not easily detected, but they may render valuable service for many years. The incisors and cuspids of the upper jaw are the only teeth which it is proper to replace in this way.

The insertion of an artificial tooth on a diseased root, or on a root having a diseased socket, is almost always followed by injurious consequences. The morbid action already existing in the root, or its socket, is aggravated by the operation, and often caused to extend to the contiguous parts, and occasionally even to the whole mouth. Even in a healthy root, it is not always

proper to apply a tooth immediately after having prepared the root. If any irritation is produced by this preparatory process, the tooth should not be inserted until it has wholly subsided. The neglect of this precaution not unfrequently gives rise to inflammation of the alveolo-dental periosteum and to alveolar abscess.

Although this method of securing artificial teeth has received the sanction of the most eminent dental practitioners, and is, perhaps, the best that can be adopted for replacing the loss of the six upper front teeth; yet, on account of the facility with which the operation is performed, it is often resorted to under the most unfavorable circumstances; in consequence of which, the method has been undeservedly brought into discredit. Apart from the proneness of operators to resort to this method when its adoption is unjustifiable, we may name two objections to the use of pivot teeth, as ordinarily prepared and inserted. First, the difficulty of preventing the presence of secretions between the crown and root, which make the breath offensive and cause the root gradually to decay. Secondly, the more or less rapid enlargement of the canal requiring frequent replacement and the ultimate loss of the fang.

The efforts of the economy for the expulsion of the roots of the bicuspid and molar teeth, after the destruction of their lining membrane, are rarely exhibited in the case of roots of teeth occupying the anterior part of the mouth. This circumstance has led us to believe that the roots of these teeth receive a greater amount of vitality from their investing membrane than do the roots of those situated farther back in the mouth; and that the amount of living principle thus supplied is sufficient to prevent them from becoming manifestly obnoxious to their sockets.

Another explanation assumes the equal vitality of all the roots, and attributes the persistence of front fangs, upon which a crown has been placed, to the continuance of that pressure to which it was subject so long as it had its natural crown. It is asserted, in maintenance of this view, that front roots, left to themselves, will disappear in the same manner as bicuspid and molar roots, and that the latter may be retained, if an artificial crown (attached to a plate) is set upon them; also, that the

process of expulsion is analogous to that by which a tooth is elongated, which has lost its antagonist.

It is well known that a dead root is always productive of injury to the surrounding parts, and that nature calls into action certain agencies for its expulsion. Therefore, attaching a tooth to a completely dead root, is manifestly improper; but the fangs of the front teeth are rarely entirely deprived of vitality, and hence, after the destruction of their lining membrane, they often remain ten, fifteen, and sometimes twenty years, without very obviously affecting the adjacent parts.

The manner of preparing a root and inserting a tooth upon it will hereafter be described.

ARTIFICIAL TEETH SECURED BY CLASPS.

This method of inserting artificial teeth, first introduced by the late Dr. James Gardette, of Philadelphia, is, perhaps, in favorable cases, one of the firmest and most secure that can be adopted. By this means, the loss of a single tooth, or of several teeth, in either or both jaws, may be supplied. A plate may be so fitted to a space in the dental circle, and secured with clasps to other teeth, as to afford a firm support to six, eight, ten, or even twelve artificial teeth.

Teeth applied in this way, when properly constructed, will last for several years, and sometimes during the life of the individual. But it is essential to their durability, that they should be correctly arranged, accurately fitted, and substantially secured to the plate; that the plate itself be properly adapted to the gums, and the clasps attached with utmost accuracy to teeth firmly fixed in their sockets.

Gold is the best metal that can be employed for the plate and clasps. For the former, the gold should be from twenty to twenty-one carats fine, and from eighteen to nineteen for the latter. If gold of an inferior quality is used, it will be liable to be acted on by the secretions of the mouth. Platina perfectly resists the action of these secretions, and would, perhaps, answer the purpose as well as gold, were it not for its softness and pliancy: in full cases, and in some partial cases, the shape of the plate may, more or less, overcome this difficulty, especially

when, as in the continuous gum work, stiffened by other materials.

The plate should be thick enough to afford the necessary support to the teeth; but not so thick as to be clumsy or inconvenient from its weight. The clasps generally require to be about one-third or one-half thicker than the plate, and sometimes double the thickness. The gold used for this purpose is sometimes prepared in the form of half round wire; but, in the majority of cases, it is preferable to have it flat, as such clasps afford a firmer and more secure support to artificial teeth than those which are half round; they also occasion less inconvenience to the patient, and are productive of less injury to the teeth to which they are attached.

Artificial teeth, applied in this way, may be worn with great comfort, and can be taken out and replaced, at the pleasure of the person wearing them. It is important that they should be very frequently cleansed, to prevent the secretions of the mouth that get between the plate and gums, and between the clasps and teeth; which becoming vitiated may irritate the soft parts, and corrode the teeth and taint the breath. This precaution should, on no account, be neglected. Great care, therefore, should be taken to fit the clasps in such a manner as will admit of the easy removal and replacement of the piece, and, also, that they may not exert any undue pressure upon the teeth to which they are applied. If the clasp, in consequence of inaccurate adjustment strains the position of the tooth in its socket, it may excite inflammation in the alveolo-dental periosteum, and the gradual destruction of the socket will follow as a natural consequence. Also, if the clasp press too closely upon the neck of the tooth, it may develop a morbid sensibility in the cementum, causing great annoyance and possibly exciting inflammation and alveolar absorption or loosening of the tooth.

ARTIFICIAL TEETH WITH SPIRAL SPRINGS.

The only difference between the method last noticed, of applying artificial teeth, and the one now to be considered, consists in the manner of confining them in the mouth. The former is applicable in cases where there are other teeth in the mouth to

which clasps may be applied: the latter is designed for confining a whole set, or part of a set, where neither clasps, nor any other means, can be successfully employed for their retention, and provided a piece is required in the lower jaw, to which one end of the springs may be secured.

When plates with spiral springs are used, the teeth are attached to them in the same manner as when clasps are employed; but instead of being fastened in the mouth to other teeth, they are kept in place by means of the spiral springs, one on each side of the artificial dentures between them and the cheeks, passing from the upper piece to the lower.

Spiral springs were formerly much used, and although various other kinds of springs have been used, none seem to answer the purpose as well as these. When they are of the right size, and attached in a proper manner, they afford a very sure and convenient support. They exert a constant pressure upon the artificial pieces, whether the mouth is opened or closed. They do not interfere with the motions of the jaw, and, although they may at first seem awkward, a person will soon become so accustomed to them, as to be almost unconscious of their presence.

Successive improvements in the process of adapting the plate to the mouth have gradually lessened the number of cases in which spiral springs are thought necessary. It is now rare to meet with a case in which they are absolutely essential for the permanent retention of the piece; but occasional use is made of them for the temporary retention of a piece made soon after extraction, in which the plate is designedly made more even than the irregular alveolar border: which plate cannot of course fit the mouth until the inequalities of the gum have yielded to the pressure of the plate.

TEETH RETAINED BY ATMOSPHERIC PRESSURE.

The method last described, of confining artificial teeth in the mouth, is often inapplicable, inefficient and troublesome, especially for the upper jaw; in such cases, the atmospheric pressure, or suction method, is very valuable. It was, for a long time, thought to be applicable only for an entire upper set, because it was supposed that a plate sufficiently large to afford the neces-

sary amount of surface for the atmosphere to act upon, could not be furnished by a piece containing a smaller number of teeth. Experience, however, has proven this opinion to be incorrect. A single tooth may be mounted upon a plate presenting a surface large enough for the atmosphere to act upon for its retention in the mouth; but, when only a partial upper set is required, it is often more advisable to secure the piece by means of clasps. For a like reason, it was thought that the narrowness of the inferior alveolar ridge would preclude the application of a plate to it upon this principle, and in this opinion the author participated; but he has succeeded so perfectly in confining lower pieces by this means, that he now never finds it necessary to employ spiral springs for their retention.

The principle upon which this plan is founded, may be simply illustrated by taking two small blocks of marble or glass, the flat surfaces of which accurately fit each other. If now the air between them is replaced by water, the atmospheric pressure upon their external surfaces, will enable a person to raise the under block, by lifting the upper. Upon the same principle, a gold plate, or any other substance, impervious to the atmosphere, and perfectly adapted to the gums, may be made to adhere to them.

The firmness of the adhesion of the plate or base to the gums depends on the accuracy of its adaptation. If this is perfect, it will adhere with great tenacity; but if the plate is badly fitted, or becomes warped in soldering on the teeth, its retention will often be attended with difficulty. It is also important that the teeth should be so arranged and antagonized, that they shall strike those in the other jaw on both sides at the same instant. This is a matter that should never be overlooked, for if they meet on one side before they come together on the other, the part of the plate or base not pressed upon, will be detached, and by admitting the air between it and the gums, will cause it to drop.

The application of artificial teeth on this principle, has been practiced for a long time. Its practicability was first discovered by the late Mr. James Gardette, of Philadelphia. But the plates formerly used, were ivory instead of gold, and could seldom be fitted with sufficient accuracy to the mouth to exclude the air; so that, in fact, it could hardly be said that they were retained by its pressure. Unless fitted in the most perfect manner, the

piece is constantly liable to drop, and the amount of substance necessary to leave in an ivory substitute, renders it so awkward and clumsy, that a set of teeth mounted upon a base of this material can seldom be worn with much comfort or satisfaction; moreover, ivory absorbs the fluids of the mouth so readily, that after being worn for a few weeks it becomes exceedingly offensive.

The firmness with which teeth, applied upon this principle, can be made to adhere to the gums, and the facility with which they can be removed and replaced, renders them, in many respects, more desirable than those fixed in the mouth with clasps. But, unless judgment and proper skill are exercised in the construction of the teeth, a total failure may be expected, or at least, they will never be worn with satisfaction and advantage.

There were few writers, at the time of the publication of the first edition of this work, who had even adverted to this mode of applying artificial teeth. Drs. L. S. Parmly and Koecker had each bestowed on it a passing notice. The former, in alluding to the subject, thus remarks: "Where the teeth are mostly gone in both, or in either of the jaws, the method is, to form an artificial set, by first taking a mould of the risings and depressions of every point along the surface of the jaws, and then making a corresponding artificial socket for the whole. If this be accurately fitted, it will, in most cases, retain itself sufficiently firm, by its adhesion to the gums, for every purpose of speech and mastication."*

It has not, until recently, been thought expedient to apply parts of sets upon this principle; nor did we, for a long time, believe the pressure of the atmosphere would give to a lower set, because of the narrowness of the alveolar ridge of the inferior maxilla, sufficient stability to render it at all serviceable; but experience has fully demonstrated its practicability.

Dr. Koecker tells us, that he has "been completely successful in several instances, in the application of sets for the upper jaw in this manner; they should be made either with a gold plate mounted with natural or artificial teeth, or of one piece of hippopotamus-tooth."† Having already stated the objections that exist to the use of this substance, we cannot join with Dr. K. in

* Practical Guide to the Management of the Teeth, pp. 138–39.

† Koecker on Artificial Teeth, p. 92.

its recommendation. At the time when we first substituted the gold plate for ivory, we had not seen his late work on artificial teeth, and, consequently were not aware that the use of metal for a base had ever before been recommended.

Modifications of the atmospherie pressure principle have been made since 1845, by constructing the plate with an air chamber or cavity, so that when the air is exhausted from between it and the parts against which it is placed, a more or less complete vacuum is formed, causing it to adhere when first introduced with greater tenacity to the gums than a base fitted without such cavity. This modification might be termed an improvement, were it not that its introduction has become so unnecessarily general, has so often induced a diseased condition of the mucous membrane, and has led to a slovenly, careless method of swaging and fitting plates. For these and some other reasons, Professor Austen regards its introduction as a positive detriment, at the same time that he acknowledges its occasional utility.

Other methods have been resorted to for the retention of artificial teeth, but as they have long since been abandoned, a description of them is rendered unnecessary.

CHAPTER FOURTH.

TREATMENT OF THE MOUTH PREPARATORY TO THE INSERTION OF ARTIFICIAL TEETH.

The condition of the mouth is not sufficiently regarded in the application of artificial teeth, and to the neglect of this, the evil effects that so often result from their use, are frequently attributable. An artificial appliance, no matter how correct it may be in its construction and in the mode of its application, cannot be worn with impunity in a diseased mouth. Of this fact, every day's experience furnishes the most abundant proof. Yet there are men in the profession, so utterly regardless of their own reputation and of the consequences to their patients, as wholly to disregard the condition of the mouth, and are in the constant habit of applying artificial teeth upon diseased roots and gums, or before the curative process, after the extraction of the natural teeth, is half completed.

The dentist, it is true, may not always be to blame for omitting to employ the means necessary for the restoration of the mouth to health. The fault, oftentimes, is with the patient. There are many, who, after being fully informed of the evil effects which much of necessity result from such injudicious practice, still insist on its adoption. But the dentist, in such cases, does wrong to yield his better informed judgment to the caprice or timidity of his patient, knowing, as he should, the lasting, pernicious consequences that must result from doing so. If he is not permitted to carry out such plan of treatment as may be necessary to put the mouth of his patient in a healthy condition, previously to the application of artificial teeth, he should refuse to render his services.

Dr. Koecker, in treating upon this subject, says, "There is, perhaps, not one case in a hundred, requiring artificial teeth, in which the other teeth are not more or less diseased, and the gums and alveoli, also, either primarily or secondarily affected. The

mechanical and chemical bearing of the artificial teeth, even if well contrived and inserted upon such diseased structures, naturally becomes an additional aggravating cause of disease in parts already in a sufficient state of excitement; if, however, they are not well constructed, and are inserted with undue means or force, or held by too great or undue pressure, or by ligatures or other pernicious means for their attachment, the morbid effects are still more aggravated, and a general state of inflammation in the gums and sockets, and particularly in the periosteum, very rapidly follows. The patient, moreover, finds it impossible to preserve the cleanliness of his mouth; and his natural teeth, as well as the artificial apparatus, in combination with the diseases of the structures, become a source of pain and trouble; and the whole mouth is rendered highly offensive and disgusting to the patient himself, as well as to others."*

The first thing, then, claiming the attention of the dentist, when applied to for artificial teeth, is to ascertain the condition of the gums and of such teeth as may be remaining in the mouth. If either or both are diseased, he should at once institute such treatment as the circumstances of the case may indicate; but as this has been described in a preceding chapter, it is only necessary now to refer the reader, for directions upon the subject, to what is there said.

When artificial teeth are to be secured in the mouth in any other way than by pivoting upon the roots, sufficient time should elapse, before their insertion, for the completion of all those changes that follow the treatment which is usually necessary in such cases; otherwise, instead of being worn with comfort, they will be a source of constant irritation. If they are applied too soon, they will lose their adaptation to the gums. We have now in our possession a number of parts of sets which had been prematurely applied; the changes in the shape of the parts on which they rested caused them to press so unequally on the gums, that their removal became absolutely necessary for the relief of the irritation and pain they occasioned. The persons from whose mouths they were taken assured us, that at the time of their application they fitted very accurately, and were worn for a short time with comfort.

* Koecker's Essay on Artificial Teeth, pp. 27, 28.

It is often necessary to wait from eight to fifteen months after the removal of the natural teeth, for the completion of the changes which take place in the alveolar ridge after extraction. In the meantime, it is generally necessary to supply the patient with a temporary substitute, as comparatively few persons are willing to remain for so long a time without. Nor on some accounts is it desirable that they should; for in this long interval the lips lose somewhat their natural expression, the under jaw forgets its natural motion, and inclines to project. The artificial piece or pieces feel more awkward and unmanageable than if inserted at once; they also interfere more with the articulation and motions of the tongue, which have become accustomed to the absence of the teeth.

Hence the insertion of artificial pieces may become advisable very soon after extraction—the interval varying from hours, or days to weeks, or months. In some of these cases the piece will have to be remodeled at short intervals; in other cases, the piece, as first made, continues to be worn for many years with much comfort. It is not easy to explain these differences. Much depends upon the nature of the mucous and submucous tissues, whether hard or soft; and much also upon the manner in which the alveolar ridge changes. It may take place rapidly, and with slight regard to the shape of the plate; in which case, the patient has to use much tact in retaining the piece in place. Or it may take place slowly; following, as it is apt more or less to do, the shape of the plate: in which case it may be worn with some comfort, or even with great satisfaction, for a long time.

A plate made immediately after extraction, should not fit the ridge exactly; but allowance should be made for the rapid absorption of the prominent edges of the alveoli. Some practitioners advise the anticipation of this process by "paring down" the alveolar ridge. This "bold surgery" has its advantages and its advocates. We think it an uncalled for cruelty.

CHAPTER FIFTH.

MANNER OF PREPARING A NATURAL ROOT AND SECURING AN ARTIFICIAL CROWN TO IT.

Previously to the preparation of a natural root for the reception of an artificial tooth, the remaining teeth and gums, if diseased, should be restored to health. This done, such portion of the crown, as may not have been previously destroyed by caries, should be removed.

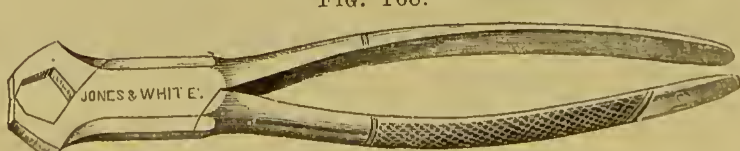
The usual method of performing this part of the operation when much of the crown remains, consists in cutting the tooth about three fourths off with a file or very fine saw, (Fig. 167),

Fig. 167.

and then removing it with a pair of excising forceps. But the forceps should not be applied until the tooth has been cut with a file on every side, nearly to the pulp cavity, and even then great care is necessary to prevent jarring, or otherwise injuring the root. When too large a portion of the crown is clipt off suddenly with excising forceps, the concussion is often so great as to excite inflammation in the socket of the tooth, and sometimes to shatter the root.

When excising forceps are used in this way, they should be strong, so as not to spring under the pressure of the hand, with

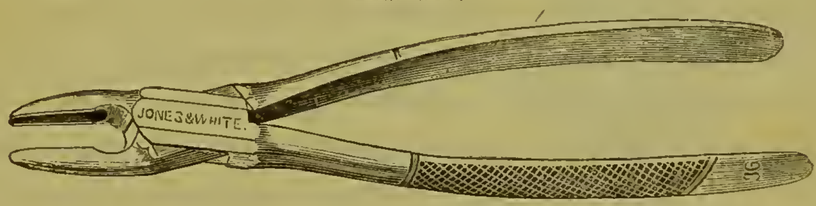
Fig. 168.



cutting edges about an eighth of an inch wide, (Fig. 168.) But we should prefer, where a large part of the crown is left, to remove it entirely with the fine saw. Where there is only a jagged

remnant of the crown left, it should be gradually cut away by a pair of cutting forceps made as light as possible, with a spring between the blades of the handle to keep them apart. The cutting edges may be shaped as in the ordinary excising forceps, (Fig. 168), or somewhat like the beaks of Parmly's duck-bill root forceps, represented in

Fig. 169.



After the removal of the remaining portion of the crown, the nerve, if still alive, should be immediately destroyed, by introducing a silver or untempered steel wire, or some other small sharp-pointed instrument, up to the extremity of the root, giving it, at the same time, a quick rotary motion. It is important that the instrument used for this purpose, should be soft and yielding, otherwise, any sudden motion of the head of the patient might break it off in the tooth. Its extremity should also be barbed or bent so as to entangle and drag out the nerve when withdrawn.

Some recommend destroying the nerve by the introduction of a hot wire into the canal of the root, but as this is very liable to produce irritation in the surrounding tissues, the other method is preferable.

The nerve having been destroyed, the remainder of the operation will be painless. The root may now be filed off, a little above the free edge of the gum, with an oval or half round file. The file should be new and sharp so as to cut rapidly, but not too coarse lest it jar the root too much. It must be kept cold and clean by frequent dipping in water. The exposed extremity of the root, after having been thus filed, should present a slightly arched appearance, corresponding with the festooned shape of the anterior margin of the gum.

After having completed this part of the operation, the natural canal in the root should be slightly enlarged with a burr-drill, or a broach prepared for the purpose. A slightly projecting point on the end of the drill will serve by entering the canal to guide the instrument, which must be held steadily in one direc-

tion. The canal thus formed in the root for the pivot should never exceed the sixteenth part of an inch or a line in diameter, and a quarter or three eighths of an inch in length.

If from any peculiar constitutional susceptibility there is reason to apprehend inflammation of the alveolo-dental membrane, the insertion of the tooth may be delayed a few days for the subsidence of any irritation which may have been occasioned by the preparation of the root. It will be prudent to do this in all cases, although it rarely happens that the operation is followed by any unpleasant effects, unless this has previously lost its vitality by the spontaneous disorganization of the nervous pulp. In this case, an outlet may be made by cutting a groove on the side of the pivot, or in some other way, for the escape of any matter which may form at the apex of the root. But it is better in such cases to extract the root unless the discharge can be permanently arrested. Dr. Maynard believes that the irritation in most cases, arises from an accumulation of acrid matter in the upper part of the root; by removing which and by filling the natural canal above the terminus of the pivot, up to the extremity, it may generally be prevented. This should always be done.

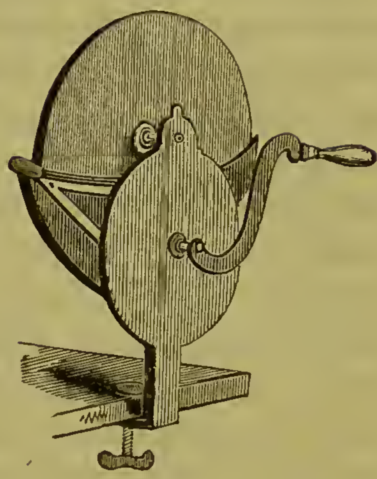
After having prepared the root, an artificial crown of the right shape, color and size, is accurately fitted to it. It should touch every part of the filed extremity of the root, and be made to rest firmly upon it, to give security of support, and to exclude food and other substances which by their decay will give rise to unpleasant odors. Care must also be used to have the tooth placed in exact line with the other teeth, not inclining unnaturally to either side, and not so long as to touch the lower teeth when the mouth is closed. To fit the crown accurately is often a tedious process, and wearies the patient. To avoid this, an impression of the space may be taken, and the crown adapted to the model, which should be hardened by varnish or soluble-glass.

The canal in the root, and that in the artificial crown, should be directly opposite to each other. When the crown of a natural tooth is used, it can be adapted to the root by the use of the file; the proper place for the pivot is indicated by the pulp cavity, but in porcelain teeth the hole is not always in the centre.

In selecting a suitable artificial pivot tooth, it is often difficult to find the several requirements of length, width, color and position of pivot hole just as required. The two last cannot be

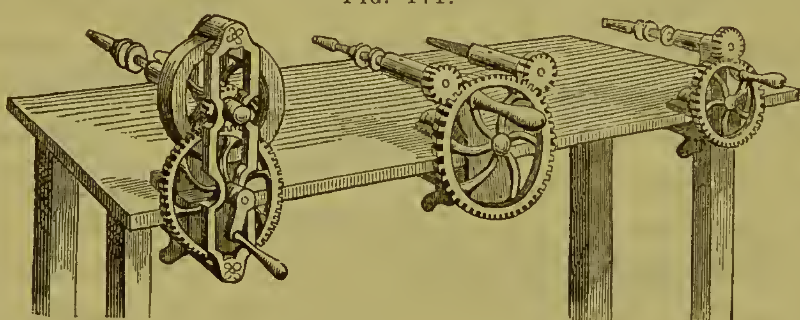
changed but the two first may often be modified by the corundum wheel. If the color cannot be exactly matched, it is perhaps better to select one a shade darker rather than lighter.

Fig. 170.



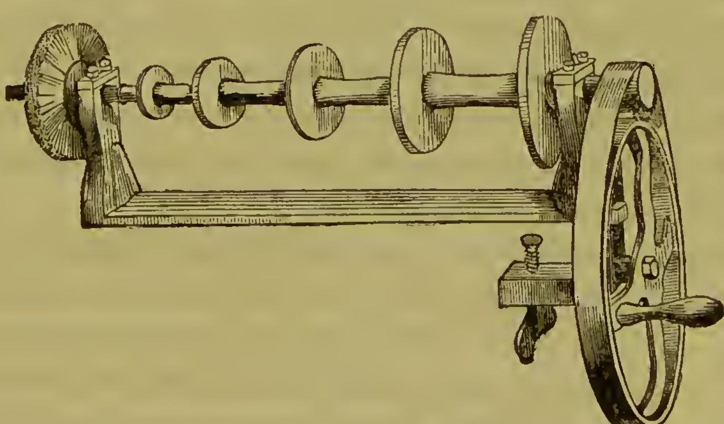
For grinding the edge, sides, or base of the tooth, any of the hand lathes in use will answer very well. Fig. 170 represents one where the wheel, either of stone or corundum, revolves in a vessel containing water. Figs. 171 and 172 represent very convenient and

Fig. 171.



useful forms of the hand lathe. The foot lathe elsewhere described is best suited for the laboratory; but, for such grinding and fitting of teeth as must be done at the operating chair, a hand lathe will be found very convenient.

Fig. 172.



The artificial crown may be secured to the root by means of a pivot made of wood or metal; when the latter is employed, gold, platina or their alloys are to be preferred, inasmuch as silver or any baser metal is liable to be oxidized by the fluids of the

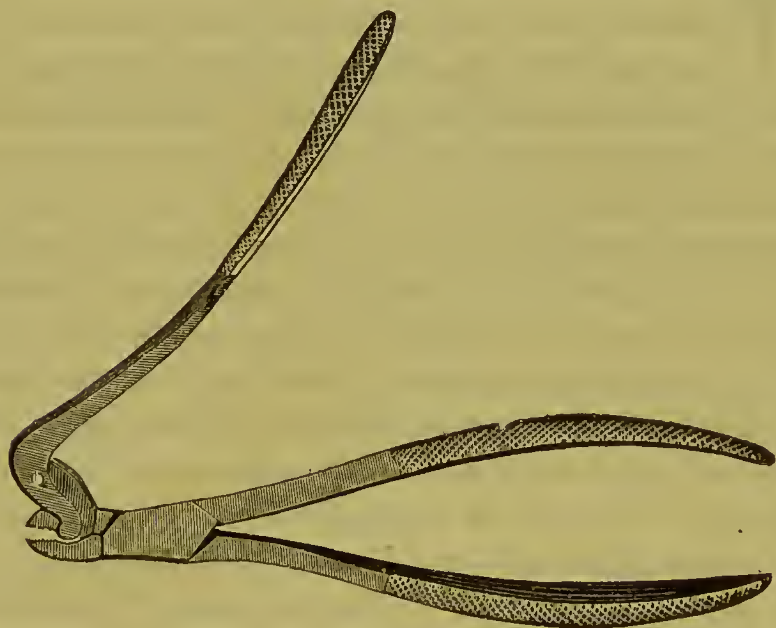
mouth. If wood is used, it should be of the best quality of well seasoned young white hickory, as this possesses greater strength and elasticity than any other that can be procured in this country. After being reduced to near the size of the orifice of the cavity in the artificial tooth, it should be forced through a smooth hole, of the proper size, in a piece of ivory, bone, steel, or some other hard substance, for the purpose of compressing its fibres as closely together as possible. Thus prepared, one end is forced into the cavity in the artificial crown, and the projecting part cut off about a quarter or three-eighths of an inch from the tooth according to the depth of the canal. If the canals in crown and root are equal in size, the pivot is ready to be pressed into place; which should be done with the thumb and fore-finger, if the pivot is made of compressed wood. But if the canals differ in size, the wood must be compressed to the size of the larger and then trimmed down to fit the smaller. The end thus trimmed should require more force for its introduction, since the compressed wood swells most from moisture. The part of the pivot going into the root, if made of compressed wood should never be so large as to require any other pressure than that which can be applied with the thumb and fore-finger; as the swelling of the wood will soon render it sufficiently tight to hold it firmly in its place, and if too tight the subsequent swelling will split the root. The practice of driving a pivot up with a hammer, or by very strong pressure as is often done, is a bad one. It is apt to cause inflammation and suppuration of the soft tissues about the apex of the root. The utmost force admissible, and this only in the case of uncompressed pivot wood, is somewhat more than can be made with the thumb and finger, applied by means of a small pine stick notched at the end to receive the cutting edge of the tooth.

It is important that the pivot should exactly equal the depth of the canal. If too long, the crown will not go up to its place: if too short, there will be either an unnecessary weakening of the root or the crown will be insecure. A small piece of smooth wire or knitting needle with a sliding collar of wood or gutta percha forms a simple instrument for measuring the depth of the canal in the root. A porcelain tooth with a wood pivot presents before insertion the appearance represented in Fig. 173.

Fig. 173.

It sometimes becomes necessary to remove the artificial crown, and in doing this, the pivot often remains in the root. For the extraction of this, the forceps represented in Fig. 174, invented by Dr. W. H. Elliott, will be found very useful. With this in-

FIG. 174.



strument the pivot may be removed from the root without jarring it in the least, or exerting any extractive force upon it. The manner of applying and using the instrument will be readily understood by examining the drawing.

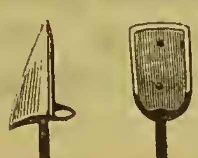
When a metallic pivot is used, the end going into the artificial crown may be fastened in either of the following ways. First, by cutting a screw on it, either with a file, or passing it through a screw plate; the cavity in the crown should next be filled with a wooden tube, and the pivot then screwed into it: or the pivot may be first screwed into a small block of pivot wood and the wood then trimmed to fit the crown. Second, by filling the pivot hole with pulverized borax, moistened with water, inserting the end of the pivot into it, which should be large enough to fill the cavity, placing several small pieces of solder around it, and fusing them with the blow-pipe. The solder, adapting itself, when in a state of fusion, to the rough walls of the cavity in the crown of the tooth, will prevent the pivot from loosening or coming out. The projecting part of the pivot should be about half an inch in

length, square and pointed. The cavity in the root, which requires to be deeper for a metallic than for a wood pivot, should be filled with wood, having a small hole through the centre. Into this, the end of the pivot is introduced and forced up, until the tooth and root come firmly together. The appearance of a porcelain tooth, prepared with a metallic pivot, for insertion in this manner is shown in Fig. 175. Another method is to have the part of the pivot that enters the root perfectly smooth and cylindrical; fit it into a block of pivot wood, and then trim the wood so as to fit the canal in the root.

FIG. 175.

But when a metallic pivot is used, a plate-tooth is preferable to one made expressly for pivoting. The manner of attaching a pivot to the former, is as follows: the root is first prepared, after which, an impression is taken; from this, a plaster model is made, and from the latter, metallic dies. This done, a piece of gold plate, large enough to cover the root, should be swaged up between the dies, a plate tooth of the proper size, shape and color, is then fitted to the root, backed with gold, and soldered to the plate. To the upper or convex surface of this last, and immediately beneath the canal in the root, a gold pivot is attached. The position and direction of this pivot is thus secured. Press the plate covered with a very thin film of wax, against the root; at the point opposite the canal, thus marked on the plate, drill a hole; through this pass the gold pivot into the canal; press softened sealing-wax around the part of the pivot (made purposely too long) below the plate, and remove the fixture from the mouth. Invest the upper part of the pin and plate in plaster, (keeping it by means of a minute collar of wax, out of the hole through which the pin passes,) remove the sealing-wax, cut off the pin even with the plate and solder. A front and side view of a tooth thus prepared is shown in Fig. 176.

FIG. 176.



A pivot, consisting of gold encased in a thin layer of wood, constitutes about as secure a means of attachment as can be employed. It is prepared in the following manner. The gold is first made into wire of the proper size, and passed through a screw-plate: a hole is then drilled lengthwise into a piece of well

seasoned hickory, as far as required for the length of the pivot, and a thread cut with the corresponding screw-tap : into this the wire is screwed, and then cut off close to the wood, which is reduced with a file or knife, to near the size of the orifice in the artificial crown, and then condensed by passing through a pivot draw-plate. Subsequent manipulations are the same as given for the simple wooden pivot; from which it differs in being stronger, also in permitting a slight bend in the pivot, in case the canals in root and crown are not in precisely the same direction. The wood prevents the gold from enlarging the cavity of the root, or from being worn by friction in the pivot hole of the artificial tooth; and at the same time, by the swelling of this encasement, the pivot is firmly retained in both.

There is some diversity of opinion with regard to the best kind of pivot. Some prefer wood, others metal. Dr. Fitch, on this subject, observes : "The metallic pivots are far better than any other ; and their only objection is, that they are apt to wear the tooth that is placed upon them, and the stump in which they are inserted; and so much so do they have this effect, that we are induced to use pivots of wood. This last has the advantage, if perfectly seasoned, of swelling in the stump, by the moisture which they absorb ; and, in this way, becoming very firm. The advantages and disadvantages of the two kinds, are, perhaps, nearly balanced."

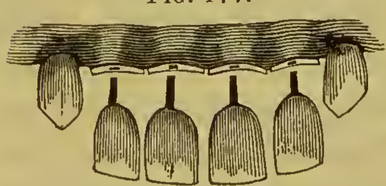
To the use of wood, Dr. Koecker is decidedly opposed. "The pivots should be made only of fine gold or platina ; every other metal, such as brass, copper, silver, and even inferior gold, are highly objectionable, being more or less liable to corrode, and thus become injurious to the other teeth and the general health. There is, however, a practice which is still more improper, namely, the use of pivots made of wood ; these pivots expand considerably after insertion, from the moisture of the mouth, and consequently remain perfectly firm in the roots for several years, which deceives not only the patient, but the dentist also, and induces them to consider the case very successful ; until they at last find that the root is either split by the swelling of the pivot, or nearly destroyed by the rapid decay of the wood in the cavity ; which, by its chemical and mechanical irritation, is very apt to produce very serious inflammation, and other affections of the

gums and sockets; by no means the least objection, is the disagreeable breath, which must be an unavoidable concomitant of this practice. I have made it an universal rule to insert the tooth in such a manner, that the patient shall be able after receiving the necessary instructions, to remove it, and replace it, at pleasure; for this purpose, I have found it best, and most effectual, to wind a little cotton round the pivot, which should be filed somewhat rough, previous to its insertion into the fang."

The description here given of the effects supposed to be produced by a wood pivot, is exaggerated. If properly made of good wood, it is no more liable to produce irritation, and to affect the breath, than one made of gold or any other metal, and wrapped in cotton. The fact that wooden pivots remain firmly in the roots for several years, ought rather to be considered as a recommendation, than an objection, and would go far towards determining our preference in their favor. The frequent removal and replacement of a pivoted tooth, greatly tends to hasten the destruction of the root, and to irritate surrounding parts, and prevents the possibility of having a firmly fitting crown. In fact, we are disposed to regard the wooden pivot, either simple, or stiffened by a gold wire, as much the best for a sound fang normally placed in the alveolus.

As a general rule, not more than two roots should be prepared at one sitting, though sometimes four, or even six, may be prepared without incurring any risk. Fig. 177 represents the roots of the four upper incisors, prepared for the reception of artificial teeth, and the teeth armed with wood pivots, ready to be inserted. The artist has not, however, given a sufficient convexity to the ends of the roots, nor carried down the points of the gum far enough between the teeth.

Fig. 177.



When a tooth is attached by any of the ordinary modes of pivoting, the walls of the canal in the root are, of necessity, exposed to the action of the fluids of the mouth, and, consequently, are gradually softened and broken down; so that, in the course of a few years, a larger pivot will be required, and this, too, will have to be again replaced with one still larger,

until, finally, the root is destroyed. This destructive process proceeds more rapidly in some cases than in others, accordingly as the root is hard or soft, and as the secretions of the mouth are in a healthy or vitiated condition. This may be prevented by introducing a gold cylinder for the reception of the pivot. This protects the walls of the canal against the action of corrosive agents, and a root thus prepared, will support an artificial crown more than twice as long as when prepared in the ordinary way. The operation, however, is more tedious and expensive, and only the larger roots will permit the enlarged size of canal required.

For the preparation of a tooth in this manner, the following is the method of procedure: First, the crown of the natural tooth is removed, the nerve, if alive, destroyed, and the canal in the root enlarged as before directed. Secondly, a screw-tap is then introduced for the purpose of cutting a screw on its inner walls. Thirdly, a corresponding screw-thread is then cut on a piece of hollow gold wire, during which process the gold tube is filled with steel wire to prevent compression. This done, it may be screwed into the root about a quarter of an inch; the wire on the inside of it is then withdrawn, and the lower or protruding extremity dressed off even with the root with a very fine file. Fourthly, an artificial tooth is selected, of the right size, shape and color, and fitted to the root; after which a gold pivot is fixed in it in the manner before described, corresponding in size and length to the gold tube in the root. Having proceeded thus far, the operation is completed by applying the tooth to the root, but little pressure being required to force up the pivot.

The stability of a tooth secured in this manner, if the pivot be of the proper size, is as great when first inserted, as one prepared by any of the other methods, and it may be removed, cleansed and replaced at the pleasure of the patient. But metal against metal inevitably wears loose, and rapidly so if removed from time to time. Hence many prefer the wooden pivot, with a wire run through its centre. When the walls of the canal are so much enlarged by decay as to have formed a conical-shaped cavity in the lower extremity of the root, the upper end only of the cylindrical screw will take effect. In this case, the space between the lower extremity and the walls of the root must be

thoroughly filled with gold before the wire on the inside is withdrawn; after which the tube and extruding portions of the gold are filed off even with the root, and polished before the artificial tooth is applied.

The hollow wire is made by partially folding a narrow, evenly-cut strip of gold around a steel mandril (a knitting-needle makes an excellent one), and passing through a draw-plate; withdraw the mandril and solder the seam; then replace the mandril, and complete the drawing until the proper thickness is given. If too thin, it will not hold the screw-thread; if too thick, it will either make the canal too small, or require too large an opening in the root. Hollow wire may be procured of the proper size at less expense of time and money than it can be made by a dentist. It is known by jewelers as *joint-wire*, because used for the hinges of breast-pins, &c.

It sometimes happens that the natural root, instead of occupying its proper position in the jaw, runs very obliquely, so that if the pivot connecting the artificial tooth to it be straight, the latter will either overlap the adjoining teeth, or else project outward or inward. To obviate this, an angle should be given to the pivot, immediately at the point of junction between the tooth and root. If this obliquity be slight, the wooden pivot, stiffened with wire, can easily be bent to suit; but in cases of greater obliquity, a solid gold pin will be required.

It sometimes happens that cases are met with presenting a still more formidable difficulty: as, for example, when the root is situated behind the circle of the other teeth. In a case of this sort, a different kind of tooth and an entirely different course of procedure is necessary. After having prepared the root, an impression of the parts are taken in wax, from which a plaster model is obtained, and from this two metallic dies. With these a gold plate is to be swaged, extending just far enough back to cover the root, and forward to form a line with the outer circle of the teeth. To the posterior part of the plate covering the root, and directly beneath the cavity in it, a gold pivot, about three-eighths of an inch long, is soldered (its length and direction is found as directed on page 618), and to the anterior part of it a plate-tooth of the right size, shape and shade is attached. A piece of hollow wood, or a hollow gold screw as

before described, is now introduced into the root, and into this the gold pivot is inserted. A side view of a right superior central incisor, mounted on a plate with a pivot, for insertion in the manner here described, is represented in Fig. 178. In Fig. 179 a back view is shown.

FIG. 178.

FIG. 179.

A description of the manner—of obtaining impressions with wax, plaster, &c.; of making plaster models and metallic dies; of fitting a plate, attaching teeth to it, and finishing it up, will be hereafter described. But before we proceed to do this, it will be proper to offer a few remarks on the manner of refining and alloying gold, and of making it into plate, springs and solder.

CHAPTER SIXTH.

MANNER OF REFINING AND ALLOYING GOLD, AND CALCULATING ITS FINENESS.

Gold, as has already been stated, is the best metal which can be employed in connection with artificial teeth, mounted in the ordinary way. It is the only one capable of resisting the actions of the secretions of the mouth, except platina, which, in this respect, answers equally well. The latter, however, is better suited for a peculiar style of work, hereafter to be described, than for the ordinary swaged plate. Although for this purpose it is used to some extent, it has no advantage in respect of purity over twenty-carat gold, and has the decided disadvantage of being heavier, softer, and more easily bent out of shape. Gold, therefore, standing first in value and importance of all the materials upon which artificial teeth can be mounted, demands our first consideration.

Although the manner of refining, alloying and manufacturing gold into plate, solder, &c., may not, perhaps, be regarded as coming properly within the province of the dentist, yet, as he often experiences great difficulty in procuring them of the right quality, a brief description of these several processes is necessary. Especially is this necessary since the dental depots seldom keep on hand any gold plate finer than eighteen carats, the use of which we consider discreditable to the profession which calls for so inferior a quality of metal, rather than to those whose business it is to supply their demands. Moreover, many practitioners are so situated that they cannot use gold plate, unless they know how to prepare it from coin.

Gold in its pure state, free from alloy, is too soft and yielding to serve as a suitable support for artificial teeth; but if it contains too much or an improper alloy, it will either be tarnished or blackened by the secretions of the mouth, or rendered too brittle for dental purposes. It is of the utmost importance that

the gold used in connection with artificial teeth should be of the proper fineness, and possessed of the requisite malleability. To secure these qualities, it is necessary to know the kind and quantity of metal with which it should be alloyed before it is made into plate or other forms necessary for the purposes for which it is to be employed.

The scraps and filings removed in shaping and reducing to their proper size and form the various pieces of gold used in the construction of a piece of dental mechanism, are apt to become mixed with base metals, such as iron from the wearing of files, and, occasionally small particles of lead, or tin. If these are melted with and permitted to remain in the gold, they will destroy its ductility, and render it unfit for a base or support to artificial teeth. Iron is less objectionable than the lead or tin, and may always be removed, before the gold is melted, with a magnet; but to free it perfectly from the others, it will sometimes be necessary to refine it in the manner presently to be described. A two-thousandth part of tin or lead destroys the ductility of gold, and even exposure to the fumes of red hot tin or lead, renders it exceedingly hard and brittle. Antimony, or bismuth, when mixed with gold, exerts upon it a very similar effect. So marked is the influence of antimony, in injuring one of the most valuable properties of gold, that its original name *regulus*, (little king,) by which it is best known in commerce, was given in view of this controlling effect upon the king of metals. It is of the utmost importance to bear in mind the action of minute quantities of these four metals, so much used in the laboratory, upon gold, platina and silver.

Platina, united with gold in certain proportions, has the effect of hardening the latter metal and making it very elastic, but does not materially affect its ductility. The affinity of the alloy for oxygen however is so great, that it is readily acted upon by nitric acid. The septic (nitrous) acid of the mouth, would, in most cases, be apt, in a short time, to corrode the metal or else make it very brittle. But for this, the two metals combined in the proportion of fifteen parts of gold to one of platina, would form an exceedingly useful alloy for the construction of spiral springs. That a combination of two metals should be thus easily acted on by an agent incapable of acting on either, when in a separate

state, may appear somewhat remarkable, but it is, nevertheless, true. We have in the effect of platina upon steel an analogous case. It makes the steel exceedingly hard and fine grained; but although itself totally insensible to the action of oxygen, when alloyed in minute quantity with steel, it causes this latter metal to oxidize with such readiness as to make it unfit for use.

Hence may be seen the fallacy of the idea entertained by many, that because platina is a more indestructible metal than silver or copper, it must necessarily make a purer plate. The properties of alloys are, in fact, so often and so widely different from those of their component metals, that they can be ascertained only by experiment. Of the three metals, platina, silver, and copper, speculative theory might select the first and purest as the best alloy for gold; whereas actual experience demonstrates that copper, itself the most injurious to the mouth, imparts most perfectly to gold, those qualities which are required in a dental plate.

In view, then, of the importance of having gold, which is to be placed in the mouth, of the right quality, every dentist, who has connected with his practice a mechanical laboratory, should have the necessary fixtures for melting and working this metal into the various forms required for dental purposes. The principal of these are, a small furnace, with crucibles and tongs, ingot moulds, an anvil and hammers, and a rolling mill; a plate-gauge, draw-plate, and bench-vice; fluxing and refining chemicals, &c. These will hereafter be described.

MANNER OF REFINING GOLD.

It is not our intention, in describing the manner of refining gold, to enter into a minute detail of the various methods employed for assaying or refining this metal; but to point out, as briefly as possible, the manner of separating it from the several metals with which it is most frequently combined in the dentist's laboratory.

The method usually employed by assayers for separating gold from silver, is, to roll the alloy out into very thin plates, and put it in nitric acid; this will dissolve most of the silver, and leave the gold behind in the form of brown plates, scales or pow-

der, which after being thoroughly washed is put into a crucible with borax and melted down into an ingot of pure gold. But this method will not succeed, unless the quantity of silver be equal to two or three times that of the gold: for the nitric acid which acts only upon the silver (and copper) cannot eat out all the alloy if its particles are too much surrounded with the particles of gold. From the old rule—one-fourth gold, three-fourths alloy—came the name given to this process, *quartration:* it is also known as the *nitric acid* process. It is well adapted to the purification of gold upon a large scale, and is the process used in the U. S. Mint. But it does not remove the platina so generally found in dentist's scrap; and is not so well adapted for gold of eighteen carats fineness and upward as the next process.

The Nitro-Muriatic or *Aqua-Regia* process dissolves all the metals of the alloy, but immediately precipitates the silver. The gold is subsequently precipitated in a state of purity, thoroughly washed, dried and melted down with borax. The process is briefly as follows. Melt the scrap to be refined; roll into a thin strip and curl it up into what is technically termed a *cornet;* place in a porcelain vessel and pour on the aqua-regia, three or four ounces to the ounce of alloy, which must be mixed at the moment of using, in the proportion of one part of pure nitric acid to two, two and a half, or three parts of hydrochloric acid; quicken the solution by heat from a spirit lamp, setting the vessel where the nitrous fumes can escape from the room: decant or filter the solution so as to separate the precipitated silver; evaporate the clear solution over a spirit-lamp nearly to dryness, add hydrochloric acid and evaporate a second time, so as to get rid of all nitric acid.

This concentrated orange colored solution is the chloride of gold together with the chloride of platina and other metals from which it must be separated by precipitation. Dilute largely with water, and add little by little, a solution of the proto-sulphate of iron, (green vitriol,) until the dark olive-brown precipitate, which instantly appears, ceases to form. Pour on this precipitate some sulphuric acid to remove all trace of iron, and then wash several times with hot water, dry it and melt with borax in a crucible.

If the presence of much platina is suspected, the solution

should be treated with muriate of ammonia (sal-ammoniac) after the gold has been removed. This will precipitate the platina which should be washed, dried, and sold, inasmuch as the dentist has no heat sufficiently intense to melt it. If the alloy to be refined consists simply of gold and platina, the aqua-regia solution, after being made neutral by twice evaporating nearly to dryness, should be diluted with water and the platina precipitated by muriate of ammonia; then decant the gold solution from the platina and precipitate the gold by the proto-sulphate of iron.

A third method of refining is the *sulphuric acid* process, which it is unnecessary to describe further than to say that it resembles the *quartation* process. Gold is melted with five to seven times as much silver, granulated and then boiled three or four hours in a platina or iron retort with sulphuric acid.

By any of these three processes, but most conveniently by the second, dental scrap may be refined to a purity sufficient for every practical purpose. The assayer resorts to other methods to obtain the absolute purity required in analyses.

Gold still containing traces of silver may be treated with sulphuret of antimony. This may be done with a strong heat in a covered crucible, and after the gold has been kept in a state of fusion for some thirty or forty minutes it should be poured out into an ingot mould, and separated from the antimony which will lie at the top. It may be necessary to melt it in this way two or three times, adding, each time, a less quantity of antimony; at the last melting, a current of air, from a pair of bellows, should be thrown upon the surface of the fused metal to evaporate the antimony, and after the vapor ceases to escape, a little refined nitre and borax should be thrown into the crucible. It should then, in a few minutes, be poured into the ingot mould and rolled; should it crack in hammering or rolling, it must be again melted, and a little more nitre and borax thrown on it.

Still another process for refining gold, is occasionally used, called cementation. It consists in first rolling the gold out into exceedingly thin plates, then placing it in a crucible with a mixture of four parts of brick-dust, one of calcined sulphate of iron, and one of chloride of soda. A bed of this mixture or cementing powder, is first placed in the bottom of the crucible;

the gold is then put in and covered with it. The crucible is covered with another crucible, the joints well luted with clay, and gradually raised to a red heat, at which temperature, it should be kept from twenty to twenty-four hours. The crucible is then removed from the fire, the top broken off, and after it has cooled the gold may be separated from the cement and washed, or what is still better, boiled in hot water.*

The form of furnace for melting gold depends much upon the kind of fuel. Charcoal, coke and anthracite are the three kinds used ; bituminous coal is inadmissible until converted into coke. The stove factories now furnish so many convenient forms for the use of any of these fuels, that we shall not occupy time or space in their detailed description. A pipe six feet high will give to the ordinary "preserving furnace" a draft sufficient to melt gold with charcoal : coke gives a very intense heat, but needs a stronger draft ; anthracite requires a powerful draft, but gives a more steady heat, need less frequent renewal, and hence is better for long continued heats.

As regards the shape and size of the stove, the following points should be attended to. Convenience of access to the crucible ; sufficient depth and width to surround the crucible with a good body of fuel, without unnecessary waste of material. Furnaces acting by simple *draft*, will be found to answer better than *blast* furnaces.

The Ceylonese goldsmiths use a blast furnace of very rude and simple construction. It consists of a small low earthen pot, filled with chaff, or saw-dust, on which a little charcoal fire is made, which is excited with a small bamboo blow-pipe, about six inches long, the blast being directed through a short earthen pipe or nozzle, the end of which is placed at the bottom of the fire. By this simple contrivance, a most intense heat may be obtained, greater, it is said, than is required for melting gold or silver.

For separating copper, tin, lead or zinc, from gold, the following simple method may be adopted ; put the gold in a clean crucible, covered with another crucible, having a small opening or hole through the top ; lute the two together with clay, place them in a bed of charcoal in the furnace, ignite the coal gradually, afterwards increase the combustion by means of a current of air

* See Chemistry of Arts, vol. ii, pp. 545, 550.

from a pair of bellows or by turning on the draft; after the gold has melted, throw in at intervals of about ten minutes several small lumps of nitrate of potash, (saltpetre,) and sub-borate of soda, (borax,) and keep it in a fused state for thirty or forty minutes; then remove the crucible, and plunge in water to cool it; break it and separate the lump of gold from the dross; then put into another crucible, melt with a little borax, and pour into an ingot-mould, of the proper size, previously warmed and oiled. The bi-chloride of mercury (corrosive sublimate) is sometimes used instead of or after the nitre, for the purpose of dissipating the base metals, and often with more certain and better results, especially where the presence of any tin is suspected. If the gold cracks on being hammered or rolled, it should be melted again, and more nitre and borax thrown into it; the inside of the crucible should also be well rubbed with borax, before the metal is put in. It is sometimes necessary to repeat this process several times, and if the gold still continue brittle, a little muriate of ammonia (sal ammoniac) may be thrown into the crucible when the gold is in a fused state; after the vapor ceases to escape, the metal should be poured into an ingot mould, warmed and oiled as before directed. This last method of treatment will make the gold tough, and prevent it from cracking under the hammer, or while being rolled, provided it is from time to time, properly annealed during the process.

By this method of refining gold, known as the *dry process*, or "refining by fire," sufficiently accurate results will be obtained for many of the practical purposes of mechanical dentistry; since the variation of an eighth or a quarter of a carat in the fineness of gold-plate is not often a matter of much consequence. Comparing the two classes of refining processes—the *humid*, by acids; and the *dry*, by fire—the first is the more accurate, and the only way to remove platina or silver; but it is the most troublesome, and requires a familiarity with chemical details, which, unfortunately, many dentists are totally ignorant of. The second may remove the lead, tin, zinc, antimony and bismuth, if in small quantity; and if continued for a sufficient length of time, with a free use of nitre, may remove a large proportion of copper. It can scarcely be depended upon if the object is to make an ingot of pure gold, but will answer admirably

if the purpose is merely to lessen the alloy or remove certain impurities.

As the dry process is one that the dentist will often have occasion to resort to, we shall give (from the seventh volume of the American Journal of Dental Science) the following description of the very excellent method pursued by Dr. Elliot, of Montreal:

"The following implements are necessary for this purpose: a small draught furnace, a quantity of fine hard-wood coal, a clean crucible with a sheet-iron cover (a lump of charcoal is better), a light pair of crucible-tongs, an ingot-mould made of soapstone, a little nitrate of potash, carbonate of potash, borax and oil. The fire-place of the furnace should be about ten inches in diameter, and eight or ten deep; this should be connected by means of a pipe with the chimney, so that a powerful draught may be made to pass through the coal. A blast-furnace is objectionable, for the reason that the bellows burns out the coal immediately under the crucible, and it is, therefore, constantly dropping down, which is not the case with the draught-furnace; besides, the draught-furnace produces a more even fire, a quality equally indispensable.

"In preparing for a heat, the furnace should be filled about half full of coal, and after it is well ignited, it should be consolidated as much as practicable without choking the draught. The crucible containing the metal and a little borax may then be set on, and more coal placed around and over it, the door of the furnace closed, and the damper opened. It should remain in this way until the gold is perfectly fused. The coal may then be removed from over the crucible, and a bit of nitrate of potash dropped in, in quantity equal to the size of a pea to every ounce of gold, and the crucible immediately covered with a plate of iron. More coal may then be placed over and around the crucible, and the gold kept in a fused state at a high temperature, until the scoria ceases to pass off, which it will do in the course of five or six minutes. The ingot-mould having been previously warmed, should be placed in a convenient position for pouring, and filled about half full of lamp-oil. The cover should now be thrown off quickly, the crucible seized with the tongs, and at the same instant another small bit of nitrate of potash should be thrown into it, and the gold rapidly, but carefully, poured into the mould.

"The ingot always cools first at the edges, and shrinks away from the middle. On that account, the mould should be a little concave on the sides, so that the shrinking will not reduce the ingot thinner in the centre than at the edges.

"Moulds of the best form will sometimes produce ingots of irregular thickness. Such ingots should be brought to a uniform thickness under the hammer, using the common callipers as a gauge. If this be neglected, the plate will be found imperfect at those points where the ingot was thinnest. The plate should be annealed occasionally during the process of hammering and rolling, and should be reduced about one number in thickness each time it passes between the rolls. If any lead, tin or zinc be mixed with the gold, the nitrate of potash must be used in much larger quantities, and, in that case, it is better to let the button cool in the bottom of the crucible. Then break the crucible, and melt it in a clean one for pouring, using borax and nitrate of potash in very small quantities for the last melting.

"In case the subject of assay be in the form of filings or dust, a magnet should be passed through it so as to remove every particle of iron, and then, instead of melting it with borax, it should be melted first with *carbonate* of potash, and afterwards with *nitrate* of potash, in quantities proportioned to the necessities of the case, as before directed. Carbonate of potash is the only flux that will bring all the small particles of metal into one mass. Without it, a great portion of the gold will be found among the scoriæ, adhering to the sides of the crucible, in the form of small globules. This process of refining answers equally as well for silver as gold."

ALLOYING GOLD.

Gold, when in an unalloyed or pure state, as before stated, is too soft to be used as a support for artificial teeth; consequently, it has been found necessary to combine with it some other metal, in order to harden it. Silver and copper are the alloys most frequently employed. Many dentists prefer the former, erroneously supposing that it does not increase the liability of gold to tarnish as much as the latter. But this opinion is sustained neither by facts nor experience. Gold, when alloyed with cop-

per, unless reduced altogether too much for dental purposes, will resist the action of acids as effectually as when alloyed with silver, and the former renders it much harder than the latter. Besides, it renders the gold susceptible of a higher and more beautiful finish. If, therefore, but one of these metals is used, copper may be regarded as preferable to silver; but four or nine parts of the former with one of the latter, constitutes a still better alloy for gold.

The gold employed in mechanical dentistry by most practitioners is altogether too impure for the purpose, it being not more than eighteen carats fine, and sometimes it is reduced even to fourteen. When not above these standards of fineness, it is discolored by the buccal secretions, imparts a disagreeable taste to the mouth, and becomes brittle after it has been worn for a few years. The plate which is to serve as a basis for artificial teeth should never be reduced below twenty carats, and as that for the upper jaw does not require to be more than one-third or one-half as thick as that of the lower, the gold for the latter may be a little finer than that employed for the former, as it is necessary that it should be more malleable. The following standards of fineness may be regarded as the best that can be adopted for gold used in connection with artificial teeth: plate for the upper jaw, twenty carats; for the lower, twenty-one; and for clasps and wire for spiral springs, eighteen.

In reducing perfectly pure, or twenty-four carat, gold to these standards, first make an alloy of copper and silver, which may be either in the proportion of copper 4, silver 1, or copper 9, silver 1, according to the qualities required in the plate. The action of the two metals are in strong contrast—copper giving hardness and elasticity and deepening the color into a red; silver preserving the softness, and giving a greenish-white shade to the original yellow of the pure gold. Of these alloys take—to twenty-one grains of pure gold, three grains; to twenty grains of pure gold, four grains; and to eighteen grains of pure gold, six grains; to make, respectively, twenty-one, twenty and eighteen carat gold. In the latter case, the alloy should be used containing most silver, as so large a per centage of copper makes the gold too hard and elastic, and gives it rather too red a color.

The gold should be first melted in a clean crucible, and as soon as it has become thoroughly fused, the silver and copper alloy may be thrown in, with two or three small lumps of borax. After keeping the whole in a melted state for some five or ten minutes, it should be quickly poured into an ingot-mould of the proper size, previously warmed and oiled. If the gold crack during the process of hammering or rolling, it must be melted again, and a few small pieces of borax, with a little muriate of ammonia, thrown in, and in five or ten minutes recast into an ingot.

When scraps and filings are to be converted into plate, they should first be refined, afterwards properly alloyed. This may also be necessary with all gold the quality or fineness of which is not known; but with national coins having a known fixed standard, this will not be necessary. When they are above these standards of fineness, the amount of alloy necessary to reduce them to the required fineness may be readily found by calculation.

In connection with the alloying of gold, it is proper to make some remarks upon the terms in which the fineness of alloys are expressed, and the means of ascertaining it.

Pure gold being taken as the starting-point, it may be expressed by unity (1), or by 24, or by 1000. In the first case, fineness is given in *fractions*. In the second case, by parts, called *carats*, which, for convenience, may be considered as equivalent to a grain; thus representing pure gold by 24 grains, or 1 dwt. In the third case, value is expressed in *decimals*, and is the most convenient system, although the second is the most customary with jewelers and dentists.

The following table, prepared by Professor Austen, will show the relative value of these three systems in a few of the most usual forms of gold alloy.

	Fractions.	Carats.	Decimals.
Pure Gold,	1.	24.	1000.
English Coin,	$\frac{11}{12}$	22.	916.6
American Coin,	$\frac{9}{10}$	21.6	900.
Dentists' Gold, best,	$\frac{5}{6}$	20.	833.3
" " good,	$\frac{4}{5}$	19.2	800.
Jewelers' Gold, best,	$\frac{3}{4}$	18.	750.
" " good,	$\frac{5}{8}$	15.	625.
" " common,	$\frac{1}{2}$	12.	500.
Commonest Solder,	$\frac{1}{3}$	8.	333.3

The table gives the amount of pure gold; subtracting which from the number at the head of each column, will give the amount of alloy. For example: best jewelers' gold contains 18 carats of pure gold and 6 carats of alloy; or three-fourths pure gold and one-fourth alloy; or 750 parts pure gold and 250 parts alloy.

To know how much alloy is required to reduce gold from one degree of fineness to another, Professor Austen gives the following rule: *Divide the lower carat* (*c*) *by the difference between the lower carat* (*c*) *and the higher* (*C*); *divide the weight* (*W*) *of the gold by this quotient* ($c \div (C - c)$), and it will give the amount of alloy (A) to be added. He also gives the following table of DIVISORS, which will be found convenient, as saving the necessity of much calculation:

Carat.	22	21	20	19	18	16	14	12
24.	11.	7.	5.	3.8	3.	2.	1.4	1.
22.		21.	10.	6.3	4.5	2.6	1.7	1.2
21.6		35.	12.5	7.3	5.	2.8	1.8	1.3
20.				19.	9.	4.	2.3	1.5
18.						8.	3.5	2.

The first vertical column represents the fineness *before* alloying; the first horizontal column the fineness *after* alloying. Example: To reduce a double-eagle (weighing 516 grains, and 21.6 carats fine) to 20, 18, and 12 carat plate, divide the weight

by $12\frac{1}{2}$, 5, and $1\frac{1}{3}$; this gives the amounts of alloy to be added —for the first, 41.3 grains; for the second, 103.2 grains; and for the third, 387 grains.

When it is required to know the fineness of the plate or solder made from known quantities of gold and alloy, *multiply the weight* (W) *of gold, before alloying, by its carat valuation* (C)*; divide this product* ($C\ W$) *by the weight of the gold after alloying* ($W+A$)*;* the quotient will be the carat value (c) of the alloyed gold.

This and the preceding rules may be also expressed by algebraic formulæ:

$$(1.)\qquad A = W \div \frac{c}{C-c} \qquad\qquad (2.)\qquad c = \frac{C\ W}{W+A}$$

The fineness of any mixture of alloys of known value may be found by a simple arithmetical rule. Multiply each weight by its carat (pure gold being 24), divide the sum of the products by the sum of the weights, and the quotient will be the carat-value of the mass.

CHAPTER SEVENTH.

MANNER OF MAKING GOLD INTO PLATE, SPRINGS AND SOLDER.

THE gold, after being refined or alloyed, as the case may be, then remelted in a clean crucible, well rubbed on the inside with borax, should be poured into an ingot-mould (Figs. 180, 181) of

FIG. 180.

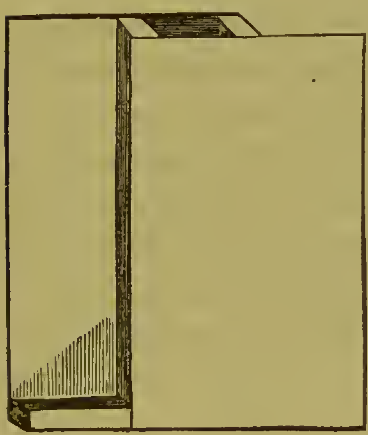
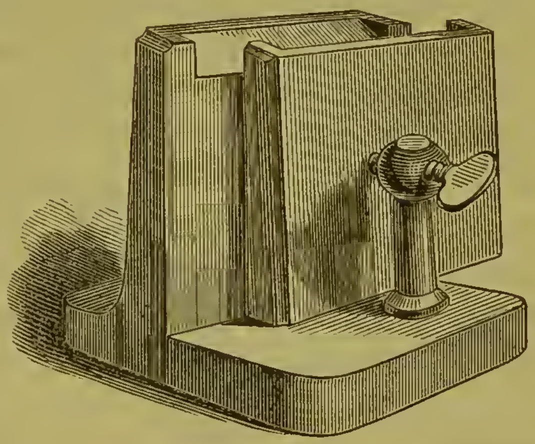


FIG. 181.



the proper length, width and thickness; then, after it has become sufficiently cool, it may be placed on an anvil, and its thickness reduced to about an eighth of an inch, with a hammer weighing from one to one and a half pounds. It should then be well annealed by being placed in the furnace, lightly covered with small pieces of charcoal, and heated until it assumes a uniform cherry-red color. It may be necessary, during the operation of hammering, to subject it once or twice to this process, to prevent the gold from cracking. If, notwithstanding this precaution, it should crack, it must be again melted, and refined with muriate of ammonia. Sudden cooling does not make it brittle. On the contrary, some jewelers maintain, that if plunged in alcohol and water, it is softer than when slowly cooled. A little sulphuric acid in the water will give a bright surface to the plate, by cleansing off the oxide of copper.

After the gold has been reduced to the thickness just mentioned, and well annealed, it may be placed between the rolls of the mill, previously so adjusted as to be the same distance apart at both ends, and not so near to each other as to require a great effort to force it between them. The rollers, however, should be brought a little nearer to each other every time the plate is passed between them, and during this process they should be kept well oiled, so that there may be as little friction as posble. Many roll the ingot without any previous hammering. In the process of rolling, care must be had to anneal often and to roll in one direction until sufficient width of plate is obtained; then, before cross-rolling, be sure to anneal, else the plate will be very apt to crack.

Rolling-mills for gold are variously constructed. Some are very simple, while others are quite complex, having a great deal of machinery connected with them. The rollers also vary in length, from three to five inches. For the gold plate used by dentists, they need not be more than three or three and a half inches long. Fig. 182 represents a simple form of rolling-mill, without the cog-gearing, as seen in Fig. 183. The latter is a strong but simple mill, and is very well suited to the dental labo-

Fig. 182.

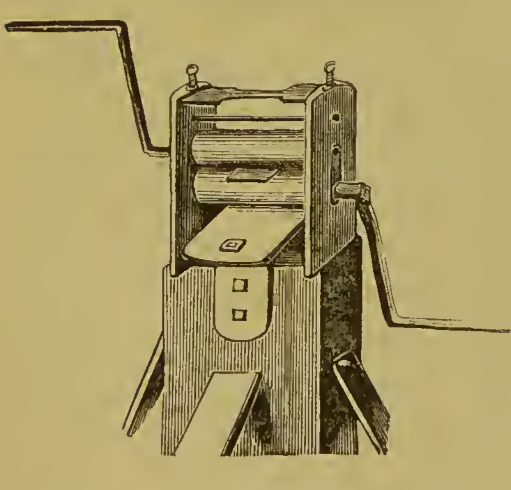
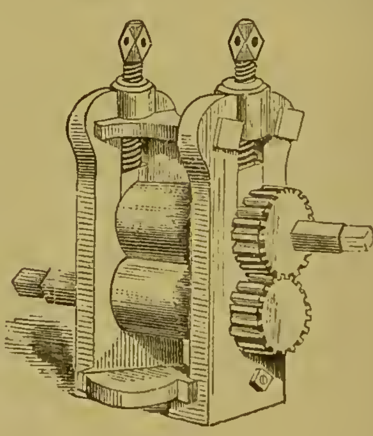


Fig. 183.



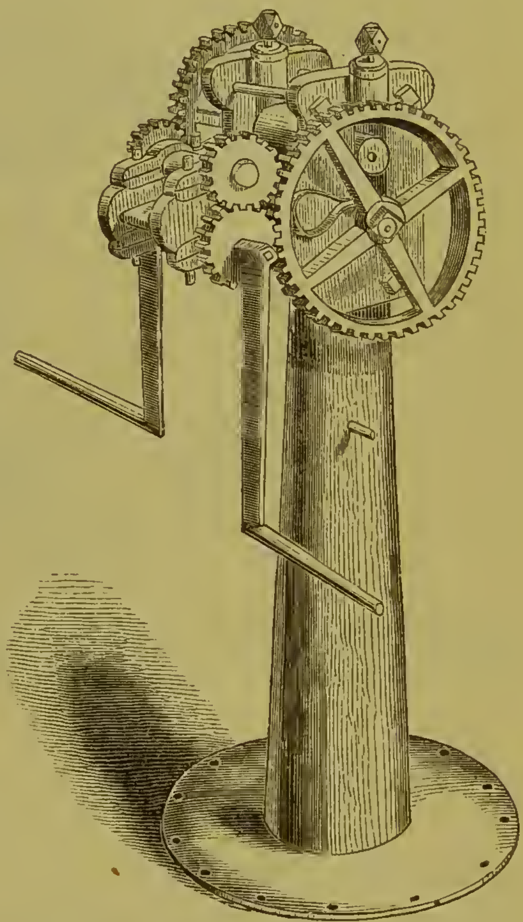
ratory. The set screws at the top are turned with a rod, and must be both moved alike, else the plate will be thicker on one side, and will curve laterally in rolling.

Fig. 184 represents a more complicated mill, designed for those who do much or heavy rolling. With such a mill, all the

rolling of a laboratory could be done without the aid of an assistant.

The thickness of the plate may be determined by a gauge-plate. That which is to serve as a basis for artificial teeth for the upper jaw may be reduced until it fits the gauge at 25, 26 or 27, according to the quality of the plate and the depth or irregularity of the arch. For the lower jaw, and for backings and clasps, it may range from 21 to 24. When the whole alveolar border and a portion of the roof of the mouth is to be covered, it may be a little thinner than when applied only to a small surface; also thinner when the arch is deep or irregular. The purer the gold is, the thicker must be the plate. When very wide clasps, too, are employed, it is not necessary that the gold should be as thick as is required for narrow ones; and low or wide backings need not be so thick as long or narrow ones. Lower plates, if wired around the edge or doubled over the middle third, may be made of the same thickness as an upper plate. But these are matters which the judgment of the dentist alone can properly determine, and, consequently, no rules can be laid down upon this subject, from which it will not sometimes be necessary to deviate.

Fig. 184.



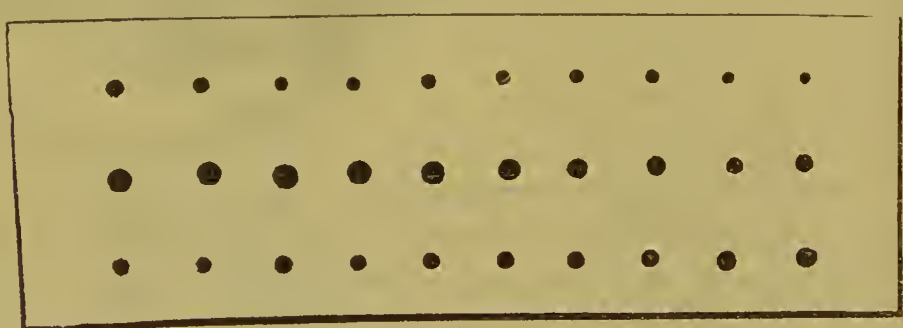
Gauge plates are, unfortunately, not uniform. For many years the most reliable were those manufactured by Stubbs. But it is difficult to procure them. At the same time, it is very important that some standard should be adopted in the profession. Under these circumstances, we approve the suggestion of

Dr. S. S. White, who recommends the gauge-plate given in Fig. 185, which has been adopted by the principal brass manufacturers of this country.

Fig. 185.

It may be necessary sometimes to make gold wire for spiral springs or other purposes; also hollow-tube wire. A draw-plate

Fig. 186.

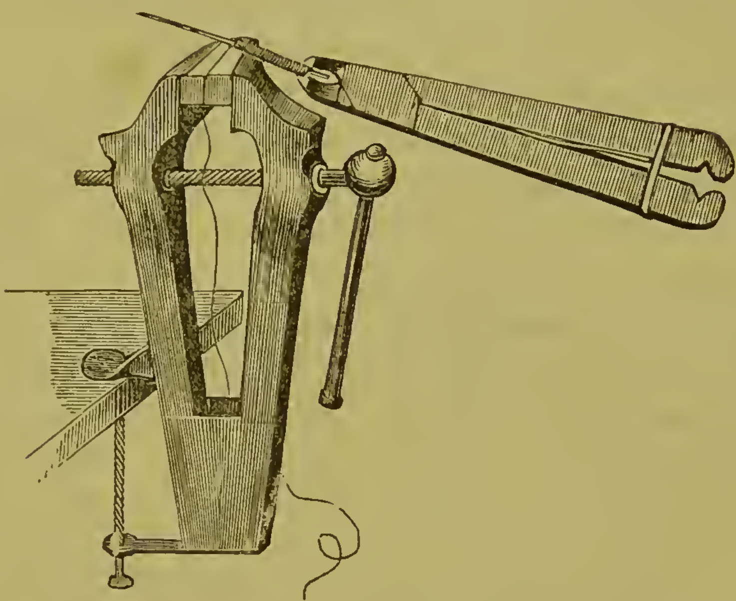


(Fig. 186), strong pliers and bench-vise (Fig. 187) are all that are necessary for this purpose. The draw-plate should be of the hardest steel, and the holes diminishing very gradually. The pliers should be rough at the end for grasping the wire, which must be often annealed during the process.

The simplest method of winding wire into a spiral spring is to secure it between two blocks of wood, held between the jaws of a small bench-vise, as shown in Fig. 187. The upper end of the wire is then grasped by a hand-vise or sliding-tongs, in connection with a spindle or steel wire, the size of a small knit-

ting-needle, six or eight inches in length. The spindle, resting on the blocks of wood, is made to revolve, and by this move-

FIG. 187.



ment the gold wire is drawn through the blocks and wound firmly and closely round the steel rod.

GOLD SOLDER.

In making gold solder, the metals employed for the purpose, if not pure, should be refined separately. Unless this is done, it will be difficult, and often impossible, to ascertain their relative purity, which should be known to insure the desired result. The gold is placed in a clean crucible with a little borax, and as soon as it has become perfectly melted, the silver, and afterward the copper, are added. When all are melted, the alloy may be immediately poured into an ingot-mould, previously warmed and oiled. The process of hammering and rolling the solder is the same as that described for gold-plate. In consequence of the large amount of alloy in solder, it is sometimes so stiff, and even brittle, as to be with great difficulty rolled. This difficulty is increased by the fact that its low fusibility makes it not very easy to anneal it without melting. This is seldom the case with solders composed of the three metals, gold, silver and copper, but only when zinc or brass are used.

In making solder into the composition of which zinc enters, the other ingredients must be thoroughly melted, then the zinc (or brass) introduced at the last moment, rapidly stirred, and the metal poured. A piece of charcoal will be found better for making small quantities of solder than a crucible.

The solder employed for uniting the various parts of a piece of dental mechanism should be sufficiently fine to prevent it from being easily acted on by the secretions of the mouth. Either of the following recipes will be found well adapted to the purpose:

FINE-FLOWING GOLD-SOLDER.

	No. 1.	No. 2.
22 carat gold, . .	48 grains.	39 grains.
Fine silver, . . .	16 "	16 "
Roset copper, . .	12 "	12 "

If pure gold is used, instead of 22 carat gold, the solder will be of finer quality, but will not flow quite so readily. The following makes rather finer solder than either of the above; and, although it requires a little stronger blast, it flows very freely:

No. 3.—Pure gold,	. . . . .	6 parts.
Fine silver,	. . . . .	1 "
Roset copper,	. . . .	2 "

By adding one or two grains of zinc, a solder may be made that will flow at a lower temperature than those made by the foregoing recipes. It will also have a finer gold color, but it is apt to impart to the piece a brassy taste, and for this reason the author rarely uses it. Zinc-solders are apt, not only to have a brassy taste, but also to become brittle after long use.

Other recipes might be added, but the foregoing have been found with us to answer every purpose. More difficulty arises in the use of solders from a wrong method of soldering than from defect in the solders themselves. Almost every dentist will be found to have his favorite recipe, which "invariably flows smoothly." The very fact that so many hundred different solders work so well, goes far to prove what we have said. Rules for the management of solder, plate and blow-pipe in the act of soldering, will be hereafter described.

CHAPTER EIGHTH.

CUPS AND MATERIALS FOR IMPRESSIONS OF THE MOUTH—PLASTER MODELS.

In the construction of a dental substitute, mounted upon a plate or base, it is necessary to obtain an exact model of the parts upon which it is to rest, and to which it is to be attached. Before this can be done, a perfect impression of these parts in some soft and yielding substance must be procured.

There are several materials which may be used for this purpose, each possessing certain advantages over the others. They are: *wax*, *gutta-percha* and *plaster of paris;* to which may be added a mixture of wax and paraffine, and a mixture of water and gutta-percha.

These materials must be contained in a cup of such size and shape as to permit easy introduction into the mouth; to be read-

Fig. 188.

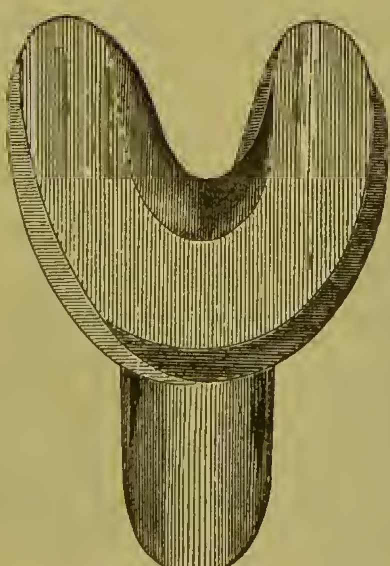
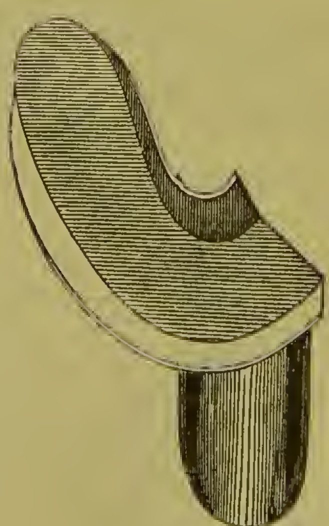


Fig. 189.



ily held for a few minutes in contact with the parts to be copied; and to follow, as nearly as possible, the outline of these parts, allowing a uniform space of one-fourth or one-eighth of an inch

for the material. These cups are known as impression-cups, mouth-cups, or wax-holders.

Formerly they were made of sheet-tin, cut into shape and soldered (Figs. 188 and 189), and were so very imperfect, that it was often necessary to swage metallic cups to suit special cases. The depots now supply an excellent assortment of well-shaped impression-cups, of which twelve will constitute a full assortment, namely: three sizes for full upper cases (Fig. 193), and

Fig. 190.

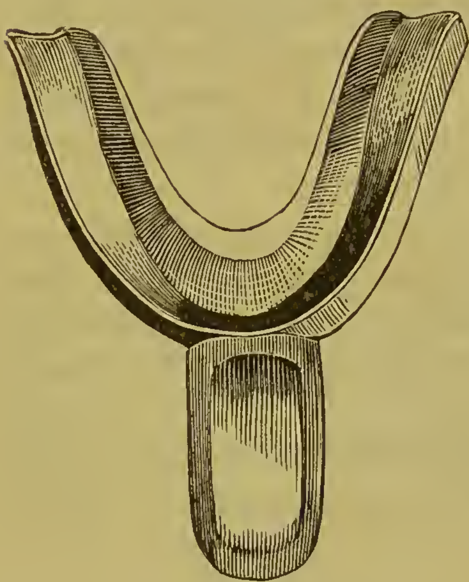
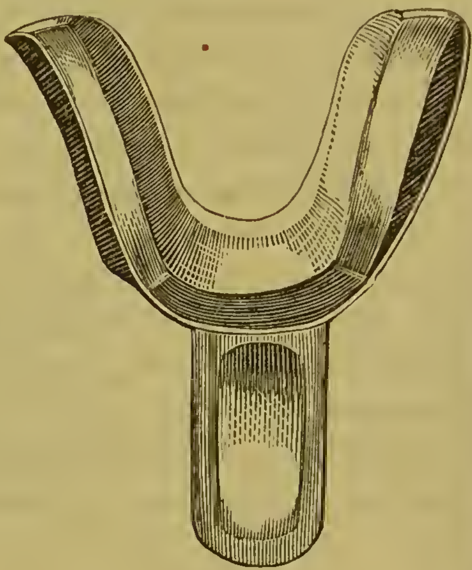


Fig. 191.



three for full lower (Fig. 190); three sizes for partial upper cases (Fig. 188), (in these the outer rim rises at a right-angle); two for partial lower cases (these cups have a depression (Fig. 191)

Fig. 192.

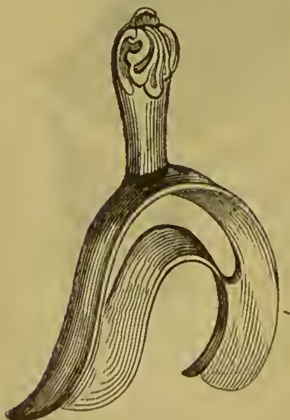


Fig. 193.

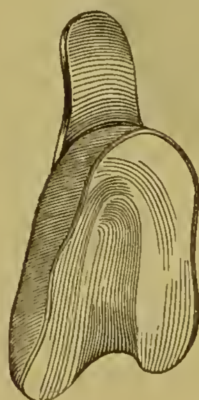


Fig 194.

or a place cut out (Fig. 192) to receive the front teeth); and a Franklin cup (Fig. 194.)

Besides these, every dentist should have a supply of gutta-percha for making cups with which to take plaster impressions, in those cases where this is the best, and often the only, material with which it can be done.

IMPRESSIONS IN WAX AND GUTTA-PERCHA.

Wax was formerly the only material used. It is, in some cases, the best, and is an indispensable material in the laboratory. The best kind of wax is yellow bees'-wax from virgin combs. Commercial impurities of lard and corn-meal injure its properties. Resin is sometimes used to harden it; and white wax is often used, because harder than the yellow. A mixture of paraffine and wax is preferred by some; but, perhaps, the best of all mixtures of wax is the compound of wax and gutta-percha. We, however, prefer pure yellow wax to any of these.

To prepare wax for impressions: melt and pour into cakes one-quarter of an inch thick; cut into pieces about two inches square; and when nearly cold, roll on a wet board with a wet wooden roller to one-half or one-fourth this thickness. This breaks down the crystallization, and reduces it to a form very convenient for softening when wanted for use. It may be softened over a broad flame, or before a fire or stove, or in warm water. In using dry heat, be careful not to melt the surface or give the peculiar whitish appearance that precedes melting. In using water, have a large quantity, to secure uniformity of temperature, and keep it at 120°—130° Fahrenheit. Below this it will not yield readily to the gum; above this it becomes adhesive.

Some practice is necessary in knowing the proper quantity of wax to use in the cup; the usual mistake is to take too much. Select a cup of proper shape and size, and if the arch is a deep one, put some hard wax or gutta-percha in the centre, to force up the wax at that point. This is much better than to have a hole in the cup through which to make pressure with the finger. Put the wax in the cup; smooth the surface, which should be a little softer than the body of the wax; then introduce and press against the gum or teeth with a steady, uniform and moderately strong pressure, made, as nearly as possible, in a direction at right-angles to the plane of the alveolar ridge.

The wax is pressed up against the gums on each side with the finger, so that an exact impression may be obtained of all the depressions and prominences on the outside of the arch. On the removal of the cup and wax from the mouth, the greatest precaution is necessary to prevent injuring or altering the shape of the impression. Holding the handle firmly, it must be drawn directly downward; or, in case there are front teeth, in the direction of the axes of these teeth. Impressions of a full upper arch sometimes adhere very tightly; but they can generally be loosened by drawing up the cheek and lip on one side or both sides alternately. The wax must be kept in the mouth long enough to cool and harden. A small piece of ice in a napkin, held against the under side of the cup, will rapidly harden it.

It will be found usually most convenient to take the impression of both sides of the mouth, although the piece may be required only for one side. But, if thought advisable, a half-cup (Fig. 189) may be used, of which a pair will be necessary.

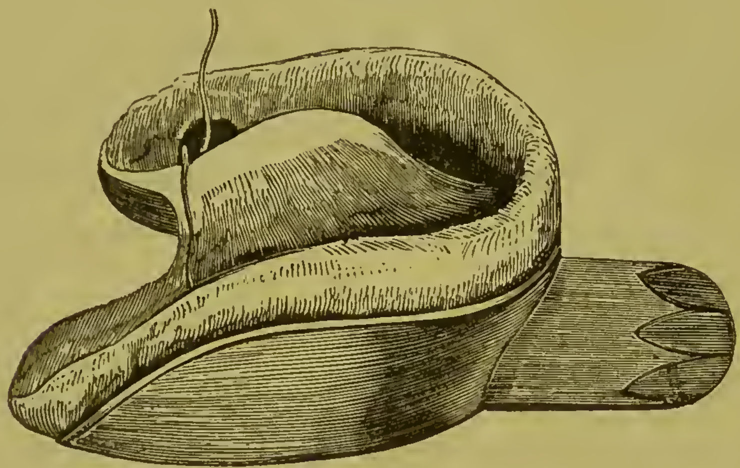
Dr. Elliot recommends that the wax-cup be "formed by being struck up between a model and counter-model, in the same way that a gold plate is fitted to the mouth."* Wax-holders, thus formed, would, doubtless, give, in certain cases, an accuracy which would will repay the extra trouble. A crude impression is first taken, model made, and then dies and counter-dies, and the plate (made of zinc, brass, German-silver or silver) *loosely* fitted. Very perfect wax impressions can be taken in such cups. In several cases, we have been compelled to construct a wax-holder in the manner described by Dr. Elliot, with which we readily succeeded in obtaining a perfect impression, after having previously made several unsuccessful attempts to procure one with the ordinary wax-holder. This process, however, is less frequently necessary than formerly, because of the improved shape of the cups now made for sale, and which are copies or modifications of a series of cups devised some years since by Dr. J. A. Cleaveland, of South Carolina.

After removing the impression from the mouth, oil may be applied to it with a camel's-hair brush, and, in partial cases, a wire about three-fourths of an inch long may be stuck into the centre of each cavity made in the wax by those teeth which it

* American Journal of Dental Science, vol. v, p. 90.

is desirable to preserve unbroken upon the model. But if oil is used upon a wax or gutta-percha impression, it must be spread *very* thin. Many careful practitioners do not use it at all.

FIG. 195.



The wax impression, prepared in this manner, will present the appearance exhibited in Fig. 195. It is scarcely necessary to add, that unless the impression is perfect, it will be impossible to fit a plate to the parts of the mouth to which it is to be applied with a sufficient degree of accuracy to be either useful or comfortable.

There are many cases in which it is impossible to remove a wax impression from the mouth without injury. In such cases, plaster of paris may be substituted. But, before describing this process, we shall say a few words of gutta-percha (in this word, the *ch* is sounded soft, as in the word perch). This exceedingly valuable material will be found useful in taking impressions of the lower jaw, and in some partial cases, also occasionally in full upper cases. The manipulations are: soften in water heated to 180°—200° Fahrenheit; dry off the water; hold for a few moments over a flame, and press into a warm cup; keep the fingers wet, to prevent the gutta-percha from sticking, but do not let water get between it and the cup. When the cup is filled, place again in water at 180°; then press it somewhat into shape and introduce into the mouth. Pressure must be more gentle than for wax. It must be kept longer in the mouth, and ice should be used to cool it. Be very careful, in partial cases where there is much undercut, or a dovetail space between

teeth, not to make the gutta-percha too hard, else it will be almost impossible to get it out of the mouth.

Gutta-percha copies surfaces with the accuracy of plaster; but, although harder than wax, it is more apt than plaster to change its shape upon withdrawing it from the mouth. The most serious objection to its use is its shrinkage on cooling: a fault which the directions above given, for making it adhere to the cup, are designed to correct. The mixture of wax and gutta-percha combine some of the valuable properties of both materials.

PLASTER IMPRESSIONS.

Gypsum, or sulphate of lime, consists of 28 parts lime, 40 of sulphuric acid, and 18 of water. A beautiful translucent variety is known as *alabaster*, and the transparent crystalline variety is called *selenite.* That, however, used in agriculture and for calcining is in amorphous masses of a grayish or bluish white color. When exposed to a heat between 300° and 400° Fahr., most of the water of the gypsum escapes. It is then known as calcined plaster, plaster of paris, or simply plaster. After being properly calcined and pulverized, if mixed with water to the consistence of thin batter or cream, it hardens in a few minutes, and acquires great solidity. The plaster has chemically reunited with a portion of the water, while another portion is mechanically held in the porous mass, and may be driven off by drying. During the process of consolidation, it expands, in consequence of the absorption of the water by the particles of plaster. If the plaster is very fine-grained, this absorption takes place quickly, and the expansion occurs while the plaster is soft. But coarse-grained plaster sets before the particles become thoroughly saturated; hence it continues to expand, more or less, for some time after solidification. There is a great difference in the quality of plaster of paris. That used for taking impressions of the mouth (and, in fact, for all dental purposes) should be of the best description, well calcined, finely pulverized, and passed through a sieve previously to being used. The idea of taking impressions for full sets of teeth with plaster of paris originated, we believe, almost simultaneously with Drs. Westcott, Dunning

and Bridges. Within the past four years Professor Austen has perfected a method of using it in connection with gutta-percha cups, which makes it, in the hands of a careful manipulator, universally applicable to every case in which a dental appliance is called for.

For plaster impressions in ordinary full cases, upper or lower, select a brittania cup about one-eighth of an inch larger than the alveolar ridge, and, in case of a deep upper arch, build up with wax, so as to give support to the soft plaster; also supply with wax any deficiency in the size of the cup at the back part or around the outside edge.

For special full cases, and for all partial cases, Professor Austen recommends a gutta-percha cup made thus: Take a wax impression, and make a model; in partial cases, brush over the *teeth* of the model one or two layers of thin plaster, to fill up all undercuts, and to make the plate fit loosely; saturate the model with water and mould over it a gutta-percha cup; it should be, on the inside, from one-fourth to one-half of an inch thick, so as to be stiff and unyielding, but on the outside not more than one-eighth or one-sixteenth thick, so as to be slightly elastic and yielding. The whole inside of the cup must be roughened up with a scaler or excavator in such a way that the plaster can take firm hold. In most partial cases, the impression must be removed in sections, the inside remaining entire, but the outside and the parts between the teeth coming away separately. In very difficult cases, it is necessary to partially cut through the cup so as to permit its removal in sections with the plaster adherent. These cups have no handle, but are removed by inserting a plugging instrument into a small hole previously made in the back part of the cup where it is thickest.

To take a plaster impression, place the patient in a common chair, and after the cup is introduced, incline the head forward, holding it in place with a gentle but steady pressure upon the centre of the cup. The plaster should be very fine-grained, and mixed rather thin, to get rid of air-bubbles. If necessary, a little salt or sulphate of potash should be added to quicken slow-setting plaster. If made to set too rapidly, it hurries the operator too much and increases the risk of failure; if it sets too slowly, both patient and operator become wearied before it

it is hard enough to remove. It should require about four minutes to harden after it is introduced into the mouth, which must be done when it is stiff enough to allow the plaster to be moulded into some shape, and yet soft enough to permit no sharp points or angles on its surface.

The hardness of plaster in the mouth can be ascertained by timing it, when the exact time required for setting is known; or by testing some of the plaster remaining in the bowl. As soon as it breaks with a sharp fracture, it should be removed. To keep it in much longer than this is apt to give unnecessary pain and difficulty in removal, owing to the absorbing property of the hardened plaster, which causes it to cling with great tenacity to the mucous membrane.

Full lower impressions are generally easy to withdraw; but some full upper ones adhere very tenaciously. Raising the cheek on one side or in front and depressing the cup, will detach most cases. This can be done, in case of plaster, without risk of injuring the shape of the impression. Where there is much undercut, the plaster will break; but it can readily be replaced. Sometimes the action of the cheeks and lips, or of the soft palate, will loosen the impression; or an instrument may be used to press up the palate, and thus cause air to pass in at the back, when it may be easily removed.

In partial cases, the outer rim (which for this purpose is made elastic, or else in sections) is first detached, and the central portion then loosened by an instrument inserted into the *back* part of the gutta-percha cup. If there should be many broken, detached fragments, either loose or caught in dovetail spaces between teeth, these must be very carefully removed; and when the surface-moisture has dried off, they must, with utmost nicety, be replaced in the impression. This is sometimes a tedious and difficult operation; but it is not trouble misapplied, since it is the *only* way in which perfect impressions of difficult partial cases can be obtained. The fragments being all adjusted and the outside ones secured by a little resinous cement, prepare the surface as in full sets for preventing the plaster of the model from adhering.

Wax and gutta-percha impressions require nothing for this purpose, or, at most, a very thin layer of oil. Plaster impres-

sions may be rendered separable: 1. By a varnish of sandarach or shel-lac, or of dilute soluble glass, with a little oil upon the varnished surface when dry; 2. by saturating it with as much oil as it will take up without standing upon its surface; 3. by coating the surface with a dilute soap mixture. The first is best applied with a small bristle-brush; the latter with a camel's-hair brush or a stiff, pointed feather. The varnish must be kept well stopped, or from time to time diluted, so as not to become thick. The soap-mixture needs occasional renewal, as the plaster gradually neutralizes its oil and renders it unfit for use.

The method of obtaining a transfer of the alveolar ridge recommended by M. Desirabode will, with proper care, secure a tolerably accurate result. It consists, after having obtained a metallic model and counter-model, in striking up a lead plate, trimming it to the proper size, and adjusting it with the finger to the alveolar border and palatine arch until it is made to fit every part with perfect accuracy. It is then carefully removed, and used, instead of the original wax impression, for the procurement of a second plaster model. From this last, new metallic castings are obtained, by means of which a plate may be made. This was, doubtless, an improvement upon some of the older methods of taking impressions: but it is certainly inferior in accuracy to the present methods with more modern appliances.

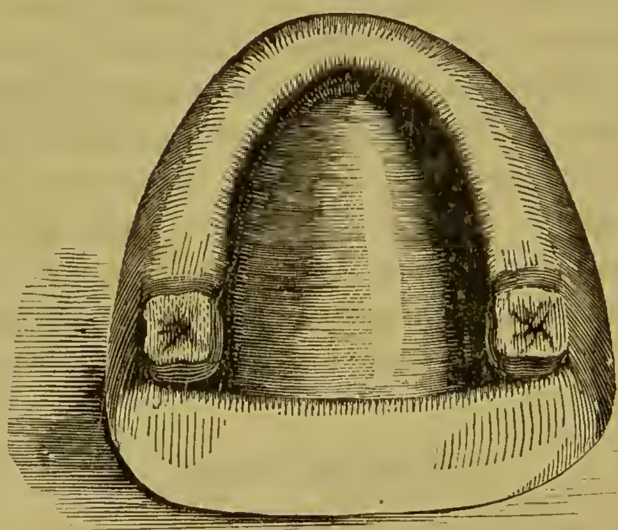
PLASTER MODELS.

After the impression has been thus prepared, it is then filled with a thin paste or batter made of the best calcined plaster of paris and water. This is at first poured in while quite thin, and with great care, until the impressions made by the teeth, if there are any remaining in the jaw, are filled; after which, the batter may be allowed to thicken a little before the remainder of the impression is filled. It is then poured on until the plaster is raised an inch or an inch and a half above the impression. A camel's-hair brush, or a feather from the wing of poultry or game, will be found very useful in spreading the plaster over the surface of the impression.

After the plaster has sufficiently hardened, it may be trimmed and removed from the impression. This is done, in the case of

wax and gutta-percha, by softening in water, being careful to make it so soft in partial cases, or when the ridge is thin, as not to break off any of the teeth or ridge. Plaster impressions may, in simple cases, be loosened by striking the back with the plaster-knife handle and removing entire. But in partial cases, and in undercut full cases, the cup must first be removed (by hot water, if of gutta-percha), and the impression then carefully detached in fragments. The same impression can sometimes be used a second or third time; but usually the shape of it is so altered in the removal of the model, that a duplicate impression is necessary if more than one model is wanted. The model may then be shaped with a knife, until it presents an appearance something like that represented in Fig. 196, having a slight flare

Fig. 196.



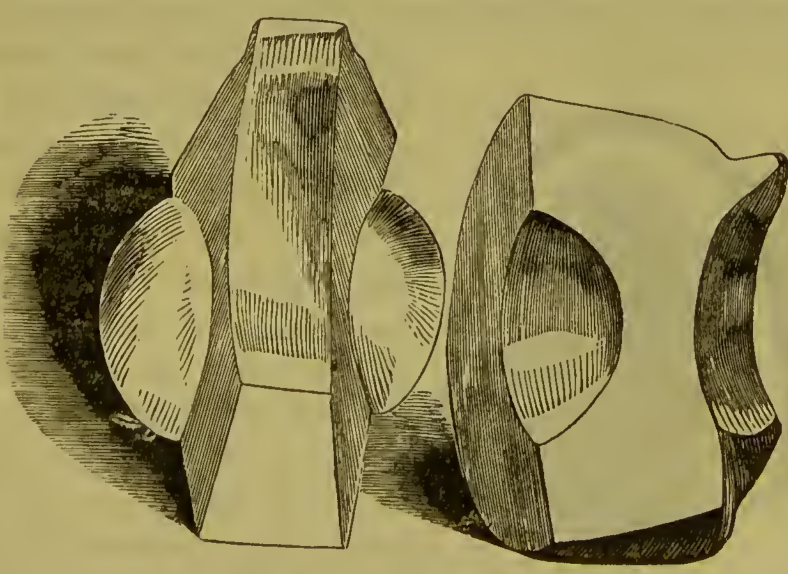
or taper, so as to admit of easy withdrawal when used in sand-moulding. This flare can be given by surrounding the impression with a tapering tin ring, more regularly than it can be trimmed with a knife.

The body of the model may be made in several ways: 1, by using the tin rings, as just stated, which is the best for deep models used in moulding; 2, by surrounding the impression with sheet-wax, waxed cloth, sheet-lead or tin-foil; 3, by filling the impression, then inverting it upon a mass of soft plaster built upon the table to the required height. The last is, perhaps, the most convenient method, except for cheoplastic models and deep models used in sand-moulding. Models for vulcanite work need

no particular shaping, as they are subsequently to be set into flasks. These should be made no deeper than is requisite for strength and they must not be varnished, unless it be with dilute soluble glass. Models from which the counter-die is made by *dipping* in lead, &c., need no special shaping, but must be thick enough to be conveniently held with the fingers whilst being dipped. No models should be varnished which are to have melted metal brought in contact with them.

In sand-moulding we may use a deep model or a very shallow one. The process with the latter will be hereafter described. In using the former, modifications of shape are sometimes called for to overcome difficulties arising from undercutting on the outside of the upper ridge and on the inside of the lower. These may be overcome: 1, by filling up the undercut with wax or plaster in all places where it is unnecessary or impracticable to carry the metallic plate; 2, by using a peculiarly-constructed flask for moulding, such as the one invented by Dr. G. E. Hawes (Figs. 201, 202); 3, by making a sectional model (Figs. 197, 198). (This method was first introduced, we believe, by Dr. A. Westcott, and is best made by filling the central third of the wax impression with the plaster, keeping it from the lateral thirds by a temporary use of clay or putty. This is then removed and trimmed, leaving the lower surface wider than the

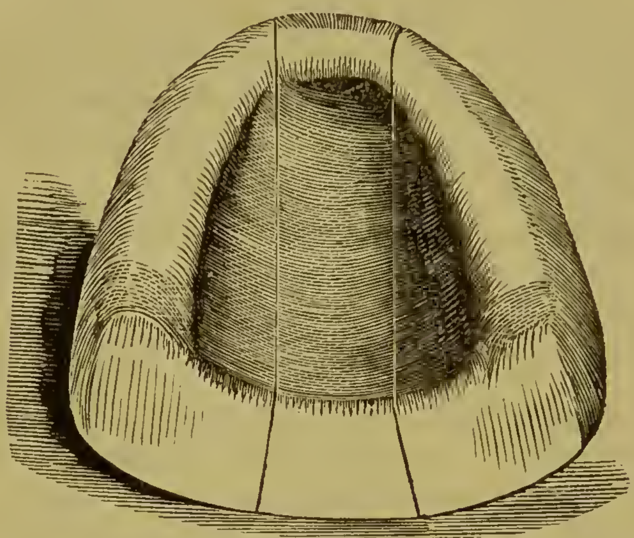
FIG. 197.



upper (Fig. 197). This done, it is replaced in the impression, and filled up on each side with plaster; the model is then re-

moved, properly trimmed, and varnished, when it presents the appearance represented in Fig. 198); 4, by filling the undercut

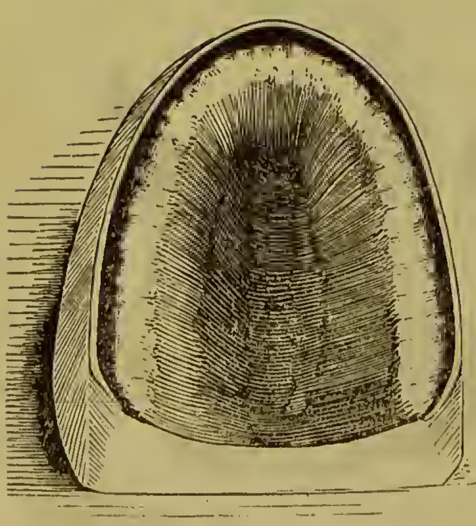
Fig. 198.



with movable pieces of plaster, technically known as *false cores*, first practiced by Professor Austen. In making the false cores, they should be shaped so as to admit of being "drawn" from the sand. At the same time, they must have a decided angle, so as to mark distinctly the place in the sand for their replacement. A small nail or tack in the sand above the core will keep it in place whilst the metal is being poured.

For striking up a plate with the outer edge turned up, a flange, about an eighth of an inch wide, is formed around the outside of the plaster model, where it is designed that the edge of the base shall terminate on the alveolar border. It may be shaped either in wax or plaster, and should stand off from the ridge at an angle of about 90° or 100°, the curvature of the rim being completed with pliers after swaging. A plaster model of the upper jaw thus prepared is represented in Fig. 199. A plate swaged with such a rim is only used for mounting gum or block teeth; it is

Fig. 199.



stronger than a simple plate and is susceptible of a more beautiful finish. For a lower set of block teeth, the edge of the plate may also be turned up all the way round. But the rim may be made of a separate narrow strip of gold, soldered to the outer edge of the plate in such a manner as to cover the outer surface of the extremities of the teeth or edge of the blocks near the base, which is, perhaps, on some accounts, preferable to a plate with a turned edge. The details of this latter method will be described in the chapter on Porcelain Block Teeth.

The model, after being trimmed, should (if dies are to be made from it by the process of sand-moulding) have several coats of shel-lac or sandarach varnish applied to it with a small bristle-brush, to give it a smooth, hard and polished surface. This will prevent it from wearing away by use, and render it more pleasant to the touch of the hand. The sandarach varnish is preferable to the shel-lac, as it is harder; it is also more transparent, and consequently, does not color the plaster. It may be made in the following manner: Take six ounces of gum-sandarach, one ounce of elemi, digest in one quart of alcohol, moderately warm, until dissolved, then add two ounces of Venice turpentine. This is, perhaps, as good a varnish as can be used for plaster models. It is easily prepared; but the alcohol should be warmed in a sand-bath or hot water, to prevent it from taking fire. To make the finest varnish, the sandarach should be of the most transparent quality, and washed in water before being put into the alcohol.

CHAPTER NINTH.

METALLIC DIES AND COUNTER-DIES—SWAGING PLATES.

Various methods have been adopted for procuring metallic dies and counter-dies. The three following are all which the author deems it necessary to describe: The FIRST of these consists in pouring melted metal into a mould or matrix made in sand with the plaster model. By this means the die is formed, and the counter-die is obtained either by immersing this in, or pouring melted metal upon it. The SECOND consists in making the counter-die first, either by immersing the plaster model in, or pouring melted metal upon it, and afterward obtaining the die by pouring melted metal in this. The THIRD consists in pouring the metal, for the metallic die, directly into the impression. A very ingenious and admirable set of flasks for this purpose have been invented by Dr. F. Y. Clark, of Savannah, and are kept for sale, we believe, by Dr. S. S. White. If the impression is thoroughly dried, the first metallic die will be perfect, no matter how much undercut there may be. A second or third may then be taken, more or less defective, but very useful for the first stages of the swaging process. Zinc is the metal used by Dr. Clark for the die.

The SECOND method admits of *three* modifications—1. The *fusible metal* process. In this the model is surrounded with thick paper, and fusible metal in a semi-fluid state is dashed over it with a spoon, the model being cold, so as to rapidly chill the metal. While still warm, the paper is removed and the counter-die trimmed with a knife, for at this temperature it can be cut as readily as cheese. The counter-die, when cold, is then smoked or coated with whiting, surrounded with paper, and more semi-fluid fusible metal dashed on it, to make the die; which process is repeated until two or six dies are made, according to the irregularity of the case.

2. The *dipping* process, which consists in pouring melted

lead, type-metal or pewter into a sheet or cast-iron cup or box, three and a half or four inches in diameter, and three inches deep, until it is half full; then stirring the fluid mass with gradually increasing rapidity until it begins to granulate, and immediately immersing so much of the plaster model as the plate is designed to cover, and holding it there until the metal congeals. It is then removed, and the whole upper surface of the counter-die covered with a thin coating of whiting or lamp-smoke in the manner before directed. After this has become perfectly dry, melted block-tin, type-metal or soft solder, at a temperature so low that it will not char, or even discolor white paper, may be poured on, until the cup or box is filled. When cold, the castings are removed from the iron cup or box, separated, and are then ready for use.

3. *Dr. Gunning's* method, in which a very thin model (made of plaster two parts, and sand or feld-spar one part) is placed in the bottom of an iron box, three and a half to four inches in diameter and about two inches deep. It is fastened there by a thin layer of plaster and sand, then thoroughly dried by raising box and all gradually to the temperature of the melted metal, which is next poured in, and the box set in a shallow vessel of water to cool it rapidly from the outside. To delay the cooling in the centre until the last moment, and so prevent contraction at that place, a very hot pointed iron, somewhat similar in shape and size to a tinner's soldering-iron, is placed upon the centre of the model before the metal is poured. When cold, this is removed and the conical space filled with metal. The counter-die is thus made of lead, alloyed with tin or type-metal. The die is made by placing over this a stout wrought-iron ring and pouring in fusible metal. Dr. Gunning uses from three to eight dies, according to the sharpness of the prominences of the model. The method gives, in his hands, very accurately fitting plates.

When metallic dies are to be obtained by the FIRST method, a moulding-box of wood is required, about six inches square and three or four inches deep. This is to be filled with fine sand, such as is used in brass and iron foundries, in the following manner: The deep or shallow plaster model is placed on the moulding-table exactly in the centre of the box, with its face upward. Sand is then firmly packed around the sides of the

model. Sand covering the face of the model should then be *sifted* on to the depth of a half inch, the box then filled, and the whole rammed with a firmness proportioned to the coarseness or dryness of the sand—damp or very fine or strong (*i.e.*, with large per centage of clay) sand not permitting so much compression as sand possessing the opposite qualities, because it would become too compact to permit the escape of the vapors formed during the process of pouring.

The box is then turned over and gently tapped several times with some light instrument or hammer, for the purpose of starting or detaching it a little from the matrix, and then carefully removed. If the model be composed of three pieces, the middle section is first removed, and afterward the two others. There are two ways of drawing the model: first, by screwing into it an excavator or gimlet, and carefully drawing it out; second, by throwing it out with a dexterous jerk of the matrix.

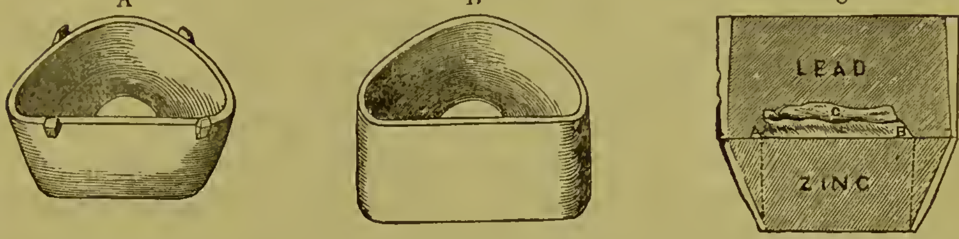
If the deep model is used, the matrix is now ready for pouring, after removing all loose sand and making a groove at the back part of the matrix to receive the first flow of the metal. But if the thin model is used, a ring must be set upon the sand after the model is removed, to give the additional size which the die requires to prevent cracking under the swaging-hammer.

The mould being prepared, the metal to be employed for the casting should be put in a tolerable thick wrought or cast-iron ladle, and melted in a common fire or furnace. If brass is used, the latter will be required to melt it; but if zinc, block-tin or lead, a common fire will afford sufficient heat. After the metal has become thoroughly melted, it is poured into the furrow formed in the sand, whence it will immediately flow into the back part of the mould. It is necessary to convey the melted metal into the mould in this way to prevent the liability to injury which it might sustain by pouring directly into it.

There have been quite a number of moulding-flasks devised to supersede the wooden one just described, or the common cart-wheel box which was once much used. Some of these are worse than useless; others are very convenient, and have the advantage of requiring a small quantity of sand, also of permitting the sand to be dried, which cannot be well done in the wooden box. The simplest, and perhaps best, flask is one recently fur-

nished to the profession by Dr. S. S. White, from patterns furnished by Dr. E. N. Bailey. Fig. 200 represents the shape and working of this flask.

Fig. 200.



Half-flask B is placed, joint-edge downward, over a thin model, and firmly packed with sand; then turned over and the sand trimmed nearly to where the plate comes on the ridge; this makes it easy to draw. Next pour zinc into the mould, and at once place on half-flask A and complete the pouring. When cool, remove the sand, invert the flask, with zinc die contained, and pour the lead (C) upon the zinc for the counter-die.

In cases of moderate undercut in front, the *thin* model can generally be drawn by a dexterous backward movement. But for a deeper undercut in front, and also at the side, the moulding-flask of Dr. Hawes (Figs. 201, 202, 203) will be found very useful.

The manner of using it is thus described by Dr. C. C. Allen: "If the model be considerably smaller than the space between

Fig. 201.

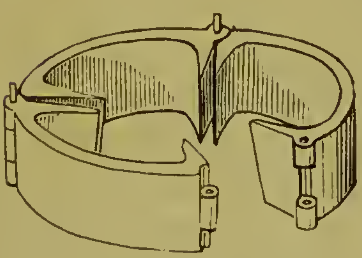


Fig. 203.

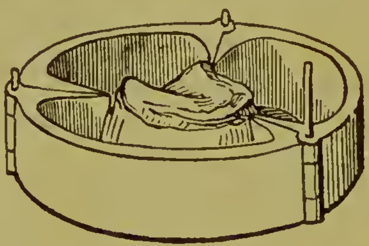


Fig. 202.

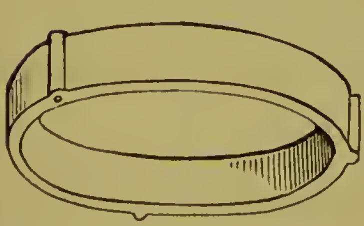


Fig. 201. The lower section of the flask, slightly opened to show joints. Fig. 202. The upper section. Fig. 203. The lower section closed, and confined by a pin, with the plaster model placed in it.

the flanges projecting inward, small slips of paper may be placed in the joint extending to the sides of the model, so as to part the sand when opening the flask, for the

removal of the pattern. The sand may now be packed around the model up to the most prominent part of the ridge. It should be finished smoothly around it, slightly descending toward the model, so as to form a thick edge of sand for the more perfect parting of the flask. The sand and face of the model must now be covered with dry pulverized charcoal, sifted evenly over the whole surface. When this is done, the upper section of the flask is placed over the lower, and carefully filled with sand. It is then raised from the lower one, which may now be parted by removing the long pin, and the model gently taken away. When closed, and the two put together again and inverted, it is ready to receive the melted metal." After the metal has cooled, it may be removed, and turned over, so that the face of the die shall be upward, while the remainder is buried in the sand. Thus placed, it is encircled with the ring (Fig. 202), and the metal for the counter-die poured upon it.

The metals most commonly used, when metallic dies are made by sand-moulding, are zinc and lead. For many reasons, these are, perhaps, the best metals for general use that can be employed. Zinc is the hardest metal that the dentist can conveniently melt. Its shrinkage is objectionable in case of deep or large arches, and for mouths where the mucous membrane is very hard. In such cases, a finishing die may be made of block-tin, type-metal, soft solder, or Babbit's-metal (a patented alloy of copper, tin and antimony, which can be obtained at any machine-shop), which last is nearly as hard as zinc, but has decidedly less shrinkage. When a metal softer than zinc is used, several dies will be necessary to complete the swaging.

A counter-die, however, should be soft. Lead is, perhaps, the best metal that can be used; but tin is not too hard if the die is made of zinc. It is desirable, if practicable, that the metal last poured (in the case of sand-moulding, this is the counter-die) should melt at a lower temperature than the other. In this respect, zinc and lead are admirably suited—zinc melting at 770°, and lead at 600°.

But in all cases of melting, it is a safe rule to pour the metals at the lowest temperature at which they will flow. It is prudent, also, to coat the metal, on which other metal is poured, with a mixture of alcohol and whiting, to prevent all chance of adhe-

sion. One more very important caution in the melting of zinc and lead is, invariably to use separate ladles.

The elastic vapor generated by the contact of the water in the sand with the hot metal sometimes collects under or rises through the metal, and renders the casting more or less imperfect. This may be prevented—1, by drying the sand; 2, by using coarse or loosely-packed sand, and avoiding too much moisture; 3, by mixing the sand with oil, instead of water. The slightest moisture on one metal previous to the pouring of another metal upon it, will make the latter imperfect. When the last metal has cooled, the castings may be separated, and, if perfect, are then ready for use.

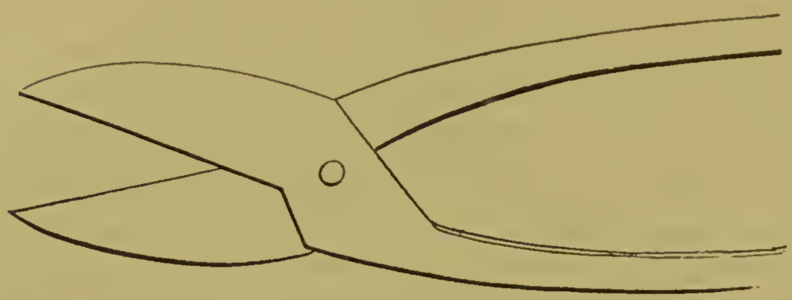
In making metallic dies for partial cases, about three-fourths of the crowns of the teeth should be cut from the plaster model before using it for moulding. The plate can thus be fitted more easily and perfectly than can be done when the teeth remain on the plaster model and zinc die; for, in the former case, the plate need not be cut to fit the teeth until it has been swaged; while in the latter, this must be done first, and, consequently, in striking it up, it will be drawn to a greater or less distance away from them. There is also danger of splitting the plate, in swaging it into the spaces between the teeth, if these are left on the metallic die.

SWAGING PLATES.

A die and counter-die having been obtained, a piece of sheet-lead is adapted to the alveolar ridge, and the dimensions of the plate marked upon it with a pointed instrument. Paper is sometimes used for this purpose, but is not so good as thin sheet-lead or heavy tin foil. The pattern thus marked is cut out, laid upon a piece of gold plate of the right thickness, and its size and shape marked upon it. The plate should be cut a little too large, to allow for trimming and any accidental slipping upon the die. In partial cases, the pattern should be carried partly over the excised teeth, and no attempt made to fit it accurately around the necks of the teeth until the swaging is nearly or quite completed. With a pair of strong shears or snips (Figs.

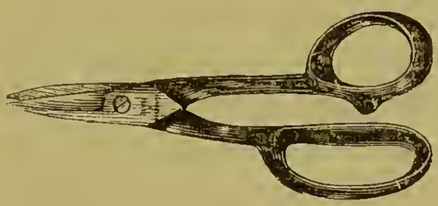
204, 205,) the portion of plate thus marked is cut out. Fig. 204

Fig. 204.



represents a pair of Stubbs' plate shears: Fig. 205, a pair of different construction, with longer and more conveniently shaped handles. The blades of some shears are curved laterally; but this form is not desirable. For curves which the straight shears will not cut, a fine watch spring saw may be used; and for very short curves, around teeth for instance, a pair of cutting forceps shaped as in Fig. 206.

Fig. 205.



The plate must next be well annealed and partially fitted, by

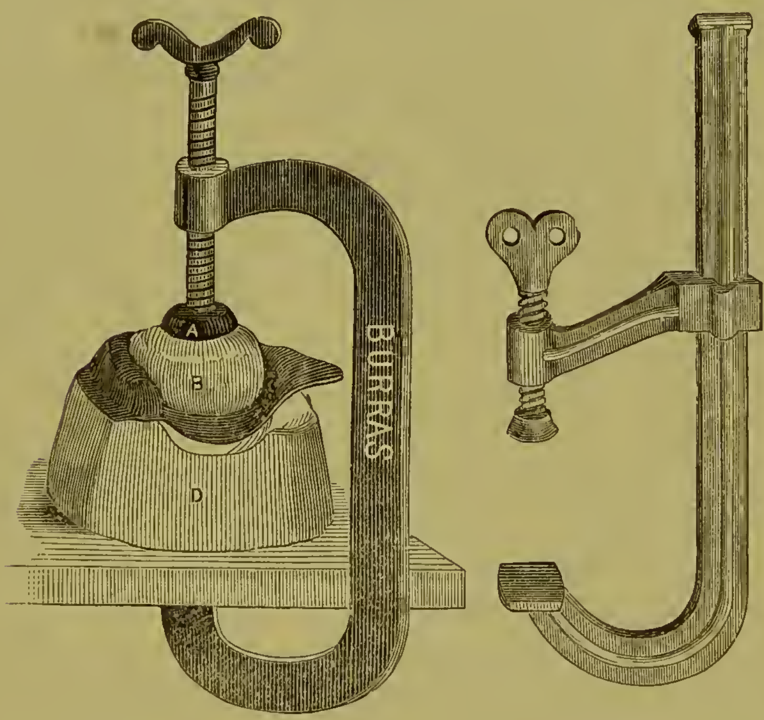
Fig. 206.

wooden, horn, or soft-metal hammers, to the part of the die inside the ridge. The swaging is continued by the use of *partial* counter-dies, which are made by placing a rim of clay or putty around the ridge and back part of the metallic die, and pouring on it fusible metal. In this way the plate is to be perfectly fitted as far as the ridge. Then clamping the plate between the die and the partial counter, the edge is to be gradually carried over the top and outside of the ridge with hammers and small wooden or ivory stakes. The plate may be clamped in a vise.

or by means of a string passing over the die and under the foot: but a more convenient and effective method is found in the use of Dr. T. H. Burras's clamps, Fig. 207. Of the two forms here given, the sliding arm (No. 2) is preferable to the long

Fig. 207.

No. 1. No. 2.



screw (No. 1). The application of the clamp is so plainly shown in No. 1, that any description is unnecessary.

It is the practice of some to cut out V shaped pieces from the front or back part of the plate, to prevent the plaiting of the metal. This is bad practice, and is never called for, if proper care is used in swaging, and the metal is of proper fineness. To avoid plaits or folds, anneal often, and in deep arches carry the plate down very gradually; also take care in such cases that the plate be thick, to allow for stretching or drawing. In swaging over the ridge it is a very common mistake to hammer down the outside before fully striking up (with hammer and stakes) the parts nearest the partial counter-die. Always make it a rule, in carrying over the ridge, to swage from the centre outward, carrying the plate "home" as you proceed.

Professor Austen regards all forms of bending forceps as worse than useless. They bruise the plate, as will any steel or hard metal instruments. There is no shape of arch or of plate which,

by the above simple process, cannot be perfectly fitted with a 20-carat plate.

The plate having been thus almost fitted by hammers and *partial* counters, it should be trimmed to its exact shape, and then placed between a fresh die and the *full* counter-die, and carried "home" by several firm blows of the hammer, given directly upon the centre of the die. The hammer should not weigh more than three pounds, with a handle about a foot long. It is a great mistake to use a very heavy or a very long handled hammer. The "striking block" may be an anvil or a large wooden block set in sand, and the base of the counter-die must rest steadily upon it. As there is always a hollow in the back of a zinc die, a conical piece of iron, steel, or other hard metal, should be placed upon it to centralize the blow of the hammer. To a disregard of these precautions is due all the difficulty, so often complained of, in the tilting or rocking of plates and dies.

Throughout the entire process of swaging the plate must be frequently annealed. It may be suddenly cooled after all except the final annealing; when the cooling must be very gradual, so as to avoid warping or springing.

When block tin, lead or fusible metal, dies or counter-dies, are used in swaging the plate, any portion of these metals which may adhere to it should be removed before annealing, as their fusion upon its surface alloys them with the gold and will render it brittle and impair its ductility, or else eat holes in the plate at the spots where the particles of baser metal form an alloy, fusible at the annealing heat. The liability of the tin or lead to adhere to the gold may be measurably prevented by oiling the plate before it is struck up.

After fitting the plate to the metallic die, it is applied to the mouth, for the purpose of ascertaining if the impression from which the model was procured is correct. It sometimes happens that this is imperfect; in which case, a new one will have to be taken, and the whole process of procuring plaster and metallic models and counter-models again gone through with; hence the propriety of the precaution of trying it in the mouth before the clasps and teeth are attached. To be worn with comfort, and at the same time to subserve any valuable purpose, it is important that the plate should fit perfectly all the inequalities of the parts

to which it is applied. When an unbroken series of several teeth are to be supplied, it seldom happens that much difficulty is experienced in fitting the plate, but when the loss of six or eight teeth, from different parts of the dental arch, are to be replaced, a perfect adaptation to the various inequalities of all the parts cannot always be so easily secured.

With regard to the size of the plate, and the special form that should be given to it in different cases, the reader will be able to form some idea from the illustrations to be given in a subsequent chapter. In full sets, the next step, after the fitting of the plate, is to obtain the antagonism of the jaws, technically termed the "articulation." But in partial cases, when it is decided to use clasps, the next process is

FITTING THE CLASPS.

The gold employed for clasps should be about one-third or one-half thicker than the plate, and when practicable, nearly as wide as the crowns of the teeth are long, and carefully and accurately fitted. Some clasps are best made of half round wire and narrow; others may be broader and thinner. Some may fit the tooth close to the gum; but in other cases, the shape of the tooth, absorption of the alveolus, or morbid sensitiveness of the neck, forbid this. Clasps must fit with accuracy, and be adjusted with great precision. This is necessary to secure to the piece the greatest possible amount of stability, and to prevent them from exercising an undue strain upon the teeth.' These are precautions which should never be overlooked; for if the clasps act unequally upon the teeth, or chafe against sensitive parts, inflammation of the alveolo-dental membrane may be set up, followed by wasting of their sockets, and ultimate loss of the teeth.

With the plate in position in the mouth a wax impression may be taken, which, adhering to the plate, will remove it on being withdrawn, and give its correct relation to the teeth which are to be clasped. Others adopt the less accurate method of adjusting the plate to the original plaster model. But as, for reasons before given, it is advisable to cut off the teeth from the model

used in moulding, a second model is necessary, and usually for this purpose a second impression.

When accurately fitted, they may be at once soldered on the model; or may be attached to the plate by means of a small piece of wax, or cement composed of one part wax and two of resin, softened, and applied to the plate and to the inner or palatine side of each clasp. The plate and clasps thus united, are carefully removed from the plaster model and laid with the convex side downward on a piece of paper.

Plaster is now poured on the upper side of the plate and clasps to the thickness of half an inch. After this has set, the piece may be taken from the paper, placed on charcoal, the wax being softened and removed, and prepared for soldering.

This is the simplest way of fitting the clasps to the plate and preparing the piece for soldering; but when the teeth in the mouth, to which these fastenings are to be applied, deviate from a vertical position, or when the teeth are of such shape that the wax impression does not copy them accurately, this method is not reliable. The clasps must then be fitted to the teeth in the mouth, instead of on the plaster model, and may then be attached to the plate, as just directed. In this case, only one can be attached at a time, and after this has been soldered, it should be opened, the piece placed back in the mouth, and the other made fast to the plate. The greatest care too will be necessary to prevent moving or altering the position of the clasp in taking the piece from the mouth.

Dr. Fogle adopts a different method for securing accurate adaptation of the clasps.* These are first fitted to the plaster model, leaving the ends straight. A narrow strip of plate, about five-eighths of an inch in length, is employed as the temporary fastening, one end of which is soldered to the lingual surface of the clasp; the plate and clasp are now both placed on the model, and the other end fitted and soldered to the plate, forming a sort of semicircle or bow. Fig. 208 represents the plate, clasps, and temporary fastenings on the plaster model. In Fig. 209 they are seen separate from the model.

The clasps are now adjusted to the model; but however accurately this is done, it will be found, on applying the plate to the

* Amer. Jour. and Lib. Dent. Sci., vol. 10, p. 35.

mouth, that they will not fit the teeth there; but after properly adjusting them, the temporary fastenings will be found sufficient

Fig. 208.

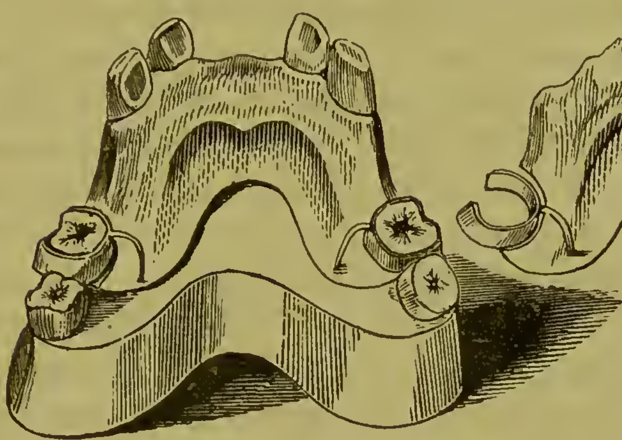
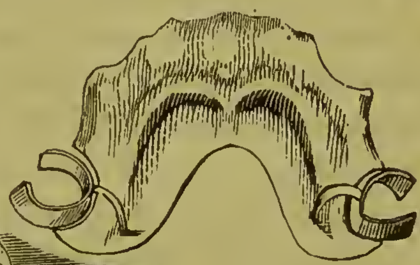


Fig. 209.



to hold the clasps, while the piece is being removed, in the exact position in which they are placed. This done, it may be invested in plaster, placed on charcoal, and the other steps connected with the process of permanent soldering gone through with.

In speaking of this method of applying clasps, Dr. Cushman says:* "In very difficult cases of adjustment, as where the clasp-teeth stand *leaning*, and where you have to fasten to the second or third molars, it will be found still more advantageous to pursue this plan—after soldering one end of the strip to the clasp, and having bent the other to touch the plate when on the model, put both in their proper place in the mouth; then with a sharp pointed instrument, indicate the point where the bow touches the plate, place them on the model again, adjust the end of the bow to the point marked, confine it there and solder fast. Dr. Cushman, who furnished the author with the model from which the drawings in Figs. 208, 209, were made, says, further, that he considers this method of adjusting clasps so valuable that he never ventures to set clasps permanently in the simplest case by the model.

Dr. Lester Noble, Demonstrator in the Baltimore College of Dental Surgery during the session of 1850–'51, suggests another method, which is thus described by Prof. Austen:

"Let the clasp bind upon the tooth only with sufficient firm-

* American Journal of Dental Science, No. 1, vol. 10.

ness to keep it in its proper place. Then mix a small quantity of plaster from a lot which, by previous trial, you find requires four or five minutes to set; put it upon a piece of paper or sheet lead about an inch square, and just before it begins to harden, introduce it into the mouth upon the fore-finger, pressing it into gentle contact with a portion of the plate and about one-half of the clasp. It must be held there for three or four minutes, until it is sufficiently hard to break with a sharp fracture; this point you can determine by examining the plaster left in your bowl. The plaster must then be withdrawn. Sometimes plate, clasp and plaster will be brought away together; or the plaster and clasp together, leaving the plate; or the plaster will separate, leaving both clasp and plate in the mouth. Should the plaster by any accident break, it can readily be united at the point of the fracture, without in the least altering its shape—one great advantage over wax. If the plaster adheres to the plate on withdrawal from the mouth, it must then be carefully detached, the plate replaced, and the same process repeated for the second clasp; or possibly the impressions for both clasps can be taken at once.

"Several precautions are necessary. If the clasp bind too tightly around the tooth, its ends will, when removed, spring together, and thus it will not exactly fill the original impression made in the plaster. If the part of the clasp which you design to cover with plaster be so regular in shape as to make its adjustment, when out of the mouth, uncertain, mark it with a file or by a small point of solder; this will be copied in the plaster, and remove all doubt as to its definite position. If the plaster be extended over some part of the edge of the plate, it will, in the absence of any marked irregularities of surface, give a better guide for its readaptation. Lastly, if the plaster cover too much of the clasp-tooth, it will be more liable to break on being withdrawn.

"Take now the clasps, place them each in their separate impressions in the pieces of plaster, securing them if necessary by a small piece of softened wax. Place one end of your plate in its corresponding bed in one of the plaster pieces. If proper care has been used, both clasp and plate will fit into the plaster with unerring accuracy, and of course hold the precise relation

as when in the mouth. While in this position, cover the clasp and the under surface of the plate with fresh plaster, or plaster and sand; when this has hardened, remove the first plaster, just as in other cases you would remove the wax, preparatory to soldering."

The methods of Drs. Fogle and Noble may be thought too tedious for cases where the shape and position of the teeth is such that a wax impression will accurately copy them; but in the majority of cases it will be found essential to accurate adjustment to resort to one or other of them.

The accurate adaptation of the clasp to the surface of the tooth is too often neglected. It is commonly done with round pliers, making trial from time to time upon the tooth of the model. Professor Austen condemns this as an uncertain method in any case, and as utterly worthless in many. He says: "Always take a separate plaster impression of the teeth to be clasped; for which purpose use a small cup of wax, lead or tin-foil, one-eighth inch larger than the tooth. Let the plaster get quite hard, then slightly open the impression, withdraw it and close up the fissure. Make from this either a plaster, or a fusible metal tooth: if the former, harden it with soluble glass."

Extreme accuracy of fit may most easily be obtained when the contour of the tooth is irregular, by the following method: Burnish down to the tooth a strip of very thin platina; then on the outside of this strip lay pieces of gold (of the fineness suitable for clasps), with borax, and flow them with the blowpipe.

The principles of soldering, and many of the appliances being the same for clasps as for soldering the teeth to the plate, they will be described in the next chapter.

CHAPTER TENTH.

PRINCIPLES AND APPLIANCES OF SOLDERING.

Soldering is the union of two metallic surfaces; either by slightly fusing the surfaces themselves (technically termed "sweating" or autogenous soldering), as in the union of a plate of silver to the block of copper preparatory to rolling it into "Sheffield plate;" or by the fusion of an alloy which melts more readily than the metals to be soldered.

The conditions of successful soldering, as given by Professor Austen, are: "1. A freely flowing solder. 2. Absence of oxide from the surface over which the solder is to flow. 3. Sufficient heat in the surface to attract and unite with the solder.

"The first condition requires good solder. Of this we have elsewhere spoken. The second calls for the use of borax, the specific action of which as a 'flux' is—first, the removal of existing oxide, by virtue of its powerful affinity for it; secondly, the prevention of further oxidation by the exclusion of the oxygen of the air. The third condition demands that skillful management of the heat, which is the principal difficulty with most beginners, and, indeed, with not a few old practitioners.

"The borax should be used in the lump, and rubbed with pure (distilled or rain) water upon a coarsely-ground *glass* slab, until a creamy paste is formed. Into this the pieces of solder may be placed, and also some of it applied with a small brush or feather to the surfaces over which the solder is required to flow. *Hard* water and the common practice of rubbing borax on a slate make it impure, and, to some extent, interfere with soldering. Too much borax is objectionable, and gold requires less than silver.

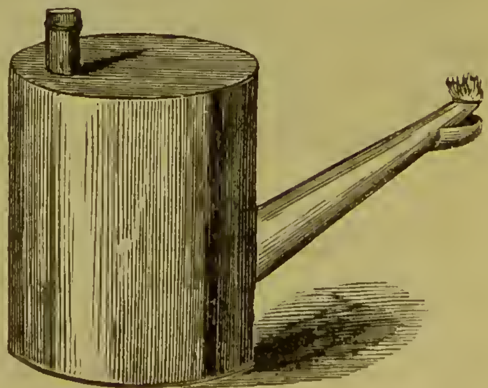
"In fulfilling the third condition—the management of the heat—the following points demand attention—(*a*) To raise the heat very gradually until the water of crystallization of the borax is slowly driven off; for if this is done rapidly, the borax

puffs up and throws off the solder; also when there are teeth, rapid heating at the outset is apt to crack them. (*b*) To diffuse the heat, when using the blow-pipe, so that the solder shall not become melted before the metallic surfaces are hot enough to unite with it; else it will roll into a ball, or flow with an abruptly-defined edge; whereas it should unite so smoothly with the plate, that, except for the difference in color, its line of termination cannot be detected. (*c*) To manage the fine point of the blow-pipe-flame as to be able to direct the flow of the solder to any given point; the rule being, that, unless prevented, solder will flow toward the hottest point. There are two kinds of flame given by the blast of the blow-pipe: 1. The broad, heating up, or oxidizing flame; this is produced by holding the tip a little behind or at the edge of the flame. 2. The pointed, soldering, or deoxidizing flame; this is produced by passing the tip more or less into the flame. A very general mistake is, to use too strong a blast.

"The apparatus required for soldering includes: a lamp to give a sufficiently hot flame; a blow-pipe to give intensity and direction to the flame; borax, brush, glass, slate, solder and solder-tongs; investing materials and clamps, to protect the teeth, also to hold the parts in relation to each other until soldered; a receptacle to retain or give additional heat during the process of soldering; an acid (sulphuric) bath to remove the glass of borax."

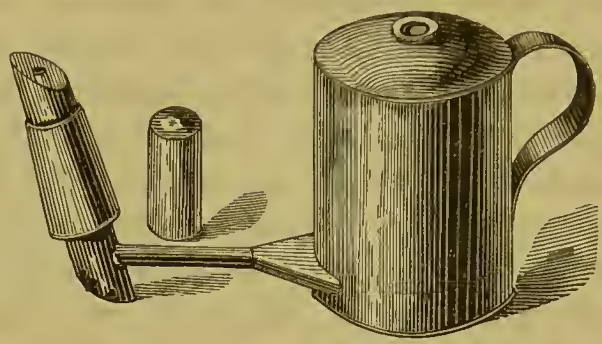
The simplest form of LAMP is shown in Fig. 210, holding about a pint, and having a wick three-fourths of an inch or one inch in diameter. As accidents sometimes occur from the flame communicating with the explosive mixture of air and alcoholic vapor in the body of the lamp, it is prudent to make a *safety-lamp* by connecting the wick-tube with the body of the lamp by a small tube, which shall be, under all circumstances, full of alcohol. Fig. 211 represents such a lamp, provided the wick is not permitted

FIG. 210.



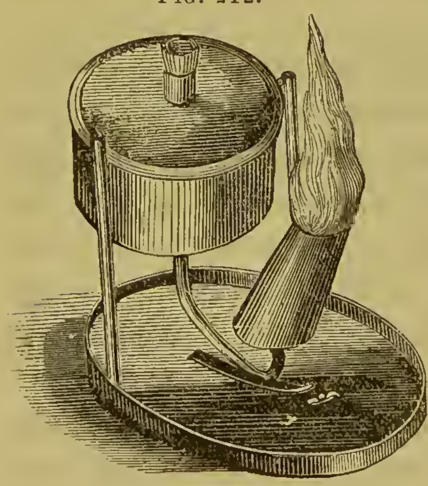
to run down as low as the horizontal tube. The top of the wick tube should be beveled off in a direction just the reverse of that

Fig. 211.



shown in the drawing, so as to permit the downward projection of the flame. Fig. 212 is a very ingenious modification of the safety-lamp, made by Dr. B. W. Franklin, so constructed as to retain the alcohol uniformly at the same level.

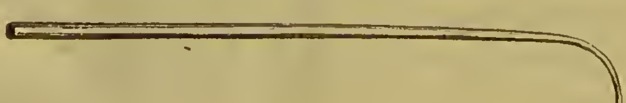
Fig. 212.



The fluid used in these lamps is usually alcohol. Æthereal oil is also used, and gives a hotter flame, but it is not quite so safe. For all purposes of soldering we regard alcohol sufficient, and it is much more cleanly than the carboniferous flame of æthereal-oil, sperm-oil or coal-oil.

Next in the order given upon page 671, is the BLOW-PIPE. The simplest is a tapering tube, fifteen to eighteen inches long and curved at the smaller end (Fig. 213). At this end the bore for the last half-inch should be *perfectly* cylindrical, and about as large as a medium-sized knitting-needle. This may be modified in several ways, and made more useful. First by cutting it within three inches of the flame-end, and inserting a small hollow ball or cylinder to receive the condensed moisture, which,

Fig. 213.

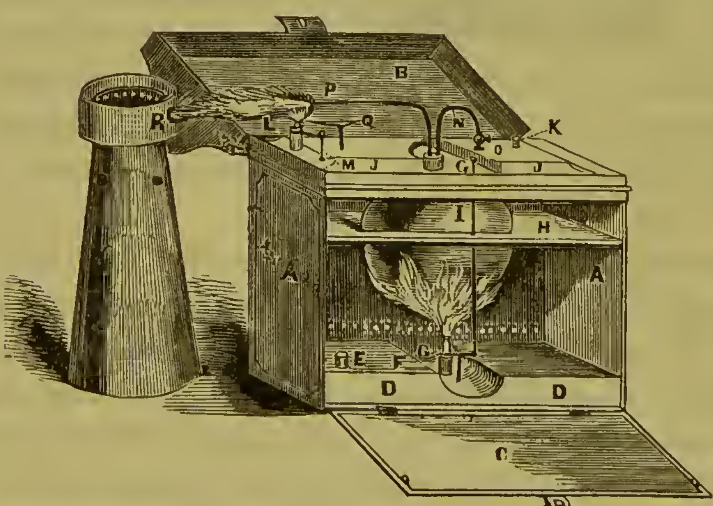


in the plain blow-pipe, often interrupts the blast. Secondly, by attaching a flattened mouth-piece, which it is much less fatiguing to the lips to grasp. Thirdly, by connecting the flame-end to the mouth-piece by from six to twelve inches of flexible tubing. This will be found to be a very valuable modification.

The mouth-blow-pipe requires for its use a peculiar management of the muscles of the chest, cheeks and palate, by virtue of which an uninterrupted and regular current of air is thrown from the lungs through the pipe. The art once learned, is never forgotten. But many will not master the first difficulty of learning it, and become the slaves to mechanical appliances, which, however useful for many purposes, can never supply the place of this simplest and best of all blow-pipes.

Blow-pipes working by artificial blast are divided by Professor Austen into four classes: 1. Alcoholic or self-acting blow-pipes; 2. Mechanical or bellows blow-pipes; 3. Hydrostatic blow-pipes; 4. Oxo-hydrogen or aero-hydrogen blow-pipes. Of each of these we shall give an example. To enumerate all the forms that inventive talent has devised would fill too much of our space.

Fig. 214.



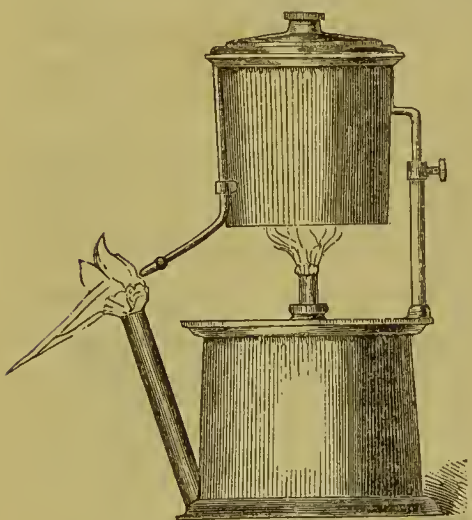
The SELF-ACTING blow-pipes derive the force of their blast from the vapor of hot alcohol, which, igniting as it passes through the flame, adds to the intensity of the heat. A somewhat complex, but very complete, blow-pipe of this class, invented by Dr. Jahial Parmly, is shown in Fig. 214.

The lamp (G), supplied from the reservoir (D D), heats the

alcohol in globe (I), supplied from the reservoir (J) through the pipe (N). The elastic vapor escapes at the jet (P), giving intensity to the large flame (L), which receives its supply of alcohol from reservoir M J. Both upper and lower wick tubes have movable cylinders for regulating the flame. A small charcoal-furnace (R) may be brought in range of the flame for melting purposes.

Smaller and more portable lamps are made, of which quite a number of different patterns are to be found in the depots. The principle and general plan of construction is very clearly shown in Fig. 215, designed by Dr. S. S. White. All alcoholic blow-pipes give intensity of heat, but are greatly inferior to the mouth blow-pipe in the control which the operator has over the force and direction of the jet.

Fig. 215.



The different forms of the MECHANICAL blow-pipe are almost infinite. The principle of construction is either that of the bellows or the force-pump, combined with a reservoir of air to give uniformity to the blast, which would otherwise issue in jets.

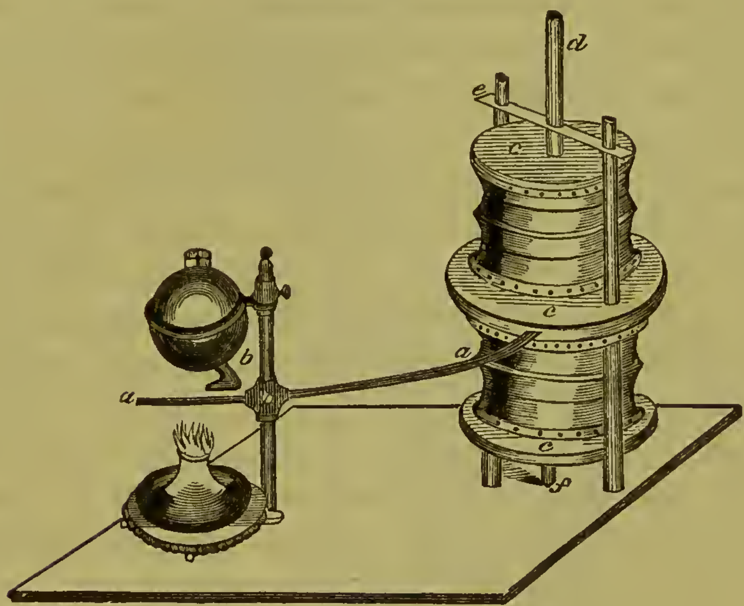
A common house-bellows, secured to the floor, will form a simple and good arrangement. A spring should separate the handles, the upper one of which forms the treadle. An india-rubber pipe should pass from the nozzle to an air-tight box, from which a second tube comes out and is attached to the blow-pipe. If the bellows is made double, like a blacksmith's, the upper half forms the air-chamber, in place of the air-tight box.

In Fig. 216 is shown a double-cylinder bellows, ten inches in diameter, moved by a treadle attached to the rod (*d f*) which passes under the soldering-table. In the drawing it is combined with an alcohol blow-pipe, as designed by Dr. W. H. Elliot, of Montreal; but it may be used independently by attaching a flexible tube, with brass point, to the air-pipe (*a a*). The fol-

lowing excellent remarks by Dr. Elliot, upon this combination, will be found very instructive:

"The fact, that the centre of the flame of the self-acting

Fig. 216.



blow-pipe contains no oxygen, is well known to every enlightened dentist, and may be proven by placing a rod of polished metal in the flame for a few seconds, in which case it will be seen that the surface of that portion of the rod occupying the centre of the flame does not unite with oxygen, however great the degree of heat may be; but if a jet of atmospheric air be thrown into the flame upon the rod, it will oxidize as readily as if heated by any other means. This little experiment proves, not only the want of oxygen in the flame, but it leads to the very important conclusion, that, without oxygen, the burning of the vapor must be gradual and imperfect. In consideration of this fact, the writer was led to make the experiment of producing a more perfect combustion by throwing into the flame one of its supporters. This may be done in several ways, but the simplest and most convenient is atmospheric air, thrown in by means of a bellows. The air from the lungs will not do as well, inasmuch as it not only contains less oxygen, but also contains a large portion of carbonic acid, which just so far renders it unfit for the support of combustion.

"The air-pipe should pass along by the vapor-pipe, and dis-

charge about an inch and a half beyond it in the very centre of the flame, and in precisely the same direction. The calibre of the air-pipe at its apex must be equal to that of the vapor-pipe. It must be made as small as possible without being enlarged at the end, as any enlargement there would derange the vapor-flame. It must also be constructed of platina, as that is the only metal that will resist, for any length of time, the heat of the burning vapor.

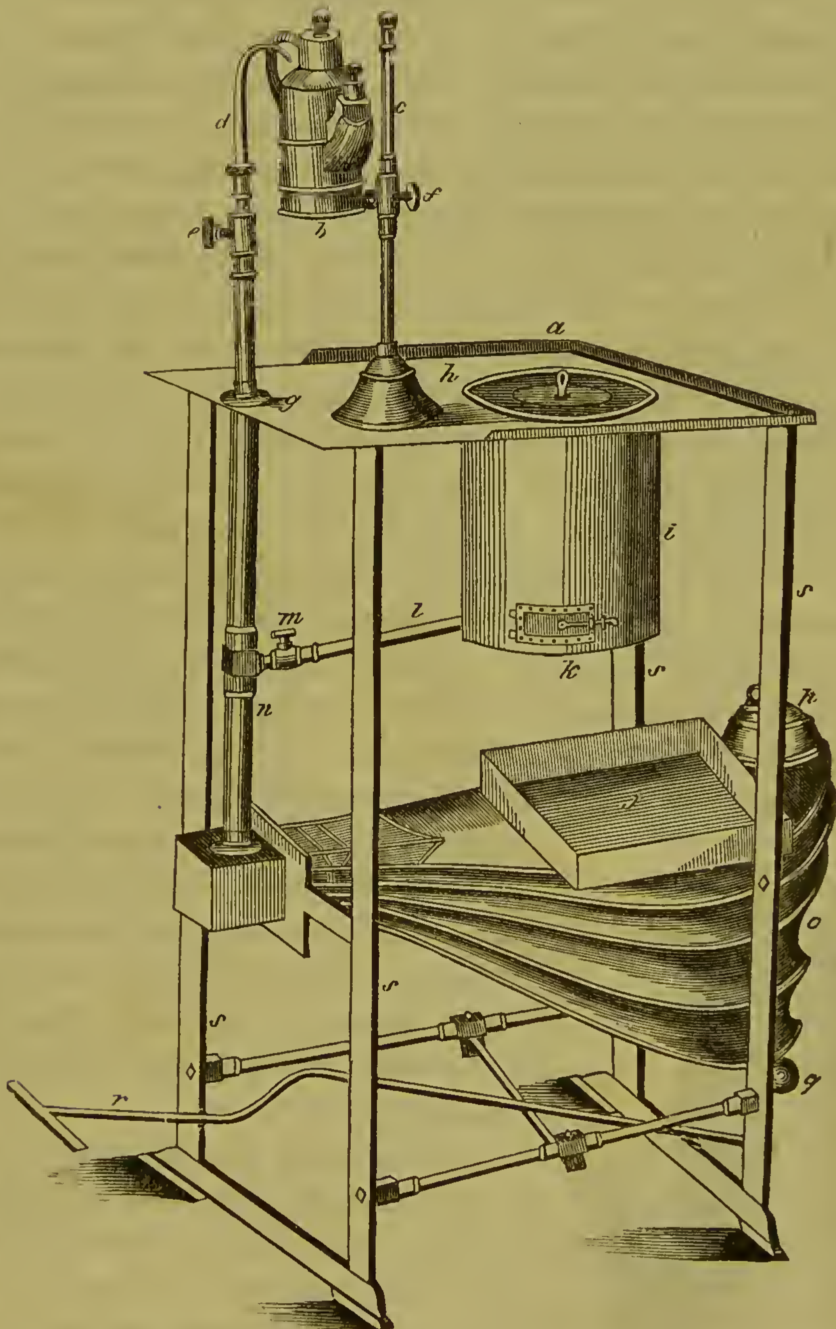
"The air-pipe appears to throw out a pale-blue flame, about two inches in length, small and pointed. At the very point of this flame, the oxygen being all consumed, the greatest amount of heat is produced, and the fusion of the solder takes place without oxidation; but within the blue flame, where oxygen preponderates, oxidation of the solder goes on rapidly. The extra heat gained by the introduction of the air-pipe is nearly all concentrated at the apex of the blue flame, which may be brought to bear upon the point, to be soldered, while the vapor-flame keeps up the temperature of the whole work."

Dr. R. Somerby, of Louisville, has constructed a combined furnace and blow-pipe, which will be found very convenient and useful in the laboratory (Fig. 217). The double bellows (*o*), worked by the treadle (*r*), sends its blast—which may be increased by the weight (*p*)—up the pipe (*n*), either to the furnace (*i*), or through the blow-pipe point (*d*) into the flame of the lamp (*b*), which rests on a sliding ring (*f*), attached to the movable stand (*h*). The frame is of cast-iron, the pipes of brass, the lamp of copper, and the entire apparatus admirably made and of the best material. When the furnace is used, a hood, resting against the flange (*a*), carries off the smoke, and a pan (*j*) receives the ashes. If desirable, the fire may be started by the blast, and then continued by simple draft through the door (*k*); this can be made of any required intensity by a pipe set directly over the top of the furnace. The process of soldering is rendered more easy by this blow-pipe than by the usual method, and is, therefore, to those of the profession who are stationary, and occupy themselves much in mechanical dentistry, invaluable. The furnace attached to it answers all the purposes of melting gold, solder and metallic casts.

"The THIRD class of blow-pipes," says Prof. Austen, "is some-

times combined with the second to regulate the blast, or with the first to intensify the blast. In its uncombined form it consists

FIG. 217.



essentially of a blow-pipe point attached by a flexible tube to an air-chamber, from which the air is forced by the steady pressure of water. When once set in operation, it is self-acting, and in this respect has great advantage over the second class. This, with the perfect regularity of the blast, makes a properly con-

structed hydrostatic blow-pipe much the best of all substitutes for the lungs and mouth blow-pipes.

"The following description will explain a simple and inexpensive apparatus contrived by me for those laboratories where no pressure can be had, as in cities, from public water-works. Place in convenient position a strong ten-gallon water-tight oak cask, two feet from the floor. Over this, and two feet above it, place a second of the same size, with a movable cover, so that water may conveniently be poured into it. Connect the casks by a tube running nearly to the bottom of the lower cask, and having a stop-cock (1) between the casks. Into the top of the lower cask insert a stop-cock (2), to which attach the blow-pipe tube, and into the bottom a larger stop-cock (3) for drawing off the water. It is prepared for operation thus: close all the stop-cocks, and fill the upper cask to within an inch of the top (if too full, it might chance to overflow the lower cask and force water out of the blow-pipe upon the flame and work); then open stop-cocks 2 and 3, and the jet issues with a force proportioned to the height of the water. If too strong, it may be regulated by pressure upon the elastic tube, or by partly closing the stop-cock. Ten gallons of air will suffice for any ordinary case of soldering; but the process is easily renewed by closing stop 1 and drawing off the water by stop 3 from the lower cask, and emptying into the upper. This can be more rapidly done if a fourth stop-cock is put in the top of the lower cask to admit air freely while drawing off the water.

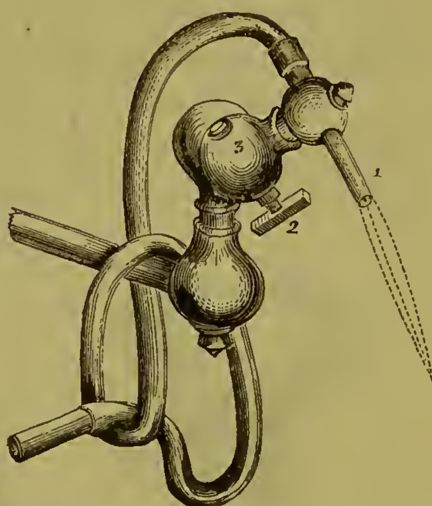
Fig. 218.

"Another but more expensive form is shown in Fig. 218, made of copper or boiler iron, and connected by lead pipes with the public water-works, in towns and cities thus supplied. The drawing, taken in connection with the previous description, makes any explanation unnecessary."

There is still another class of blow-pipes, analogous in their operation to the oxo-hydrogen blow-pipe. The point is double,

consisting of a tube, through which comes the supporter of combustion (oxygen or common air), surrounded by a cylinder, through which comes the combustible (alcoholic vapor, illuminating gas or hydrogen). In Count Richmont's aero-hydrogen blow-pipe, the hydrogen is generated in a vessel by the action of dilute sulphuric acid upon zinc, and the air forced through the centre tube either with a bellows or from the lungs. The heat is less intense than that of the oxo-hydrogen blow-pipe, but is too great for most laboratory purposes. In the various forms of "gas blow-pipes" the principle is similar and the heat very great. It is a very convenient instrument. Fig. 219 reprepresents Macomber's gas blow-pipe. The direction of the point (1) is regulated by the joint (3), and the supply of gas controlled by the stop-cock (2). The air is supplied from the lungs through the flexible tube.

FIG. 219.



Parts to be soldered must be held together in their exact relative position. This can sometimes be done by simply laying them together; but usually they must be held in place, either by iron-wire bound round them, or by small clamps of iron-wire, or by rivets, or else by some investing material, which, in dentistry, is always plaster mixed with some substances that will counteract its tendency to shrink and crack under soldering heat. This substance may be coal-ashes, soap-stone dust, feld-spar, clean sand or asbestos. The two latter are the best, and may be mixed in proportions varying from two to six parts sand or asbestos to four of plaster. As a rule, the less plaster, the less the shrinkage; but too small a quantity makes the investment rotten.

A common mistake is, to use too large a quantity of investing material. This almost invariably results in the warping of the plate; for, as *all* investments have some degree of permanent contraction, and *all* metal must expand, if the latter is bound by a rigid, unyielding mass, it will inevitably warp. Hence, as a rule, use no more investing material than is necessary to keep

the parts to be soldered in their position, and to proteet the poreelain surfaces from direct eontact with the flame. This subject will be further considered when speaking of the soldering of teeth to the plate.

In selceting a suitable receptaele for the work to be soldered, it is important to retain the heat, cspeeially when using the mouth blow-pipe. A funnel-shaped mat made with seraps of woven iron-wire, or a large lump of pumiee-stone, or one of close-grained charcoal with the outside eoated over with a thin layer of plaster, form very simple and eonvenient receptaeles for smaller pieces of work. For larger work, or for very high temperatures, it is important to receive additional heat from ignited charcoal, for which purpose the soldering-pan (Fig. 220) is a very admirable contrivanee. The movable lid remains during the heating up and the cooling off, but is, of course, removed during the aet of soldering.

Fig. 220.

After soldering, the work should cool gradually, unless it is to be re-swaged. If there is any porcelain, the cooling must be very gradual. When cold, it may be plaeed in dilute sulphurie acid and slowly raised to the boiling point, kept there for a few moments, then slowly cooled. This dissolves the glass of borax, which is very hard, and will take the edge off from files and scrapers.

The application of these rules and apparatus to the soldering of clasps is very simple. The surfaces must be free from plaster or oxide, and the points to be united must not be too widely separated. The clasp should be firmly united, but the line of union must not be too wide, else the proper spring or play of the ends of the clasp will be lost. Too much solder or too much borax makes slovenly work. A perfectly soldered joint never needs the file or scraper to give it a finish.

CHAPTER ELEVENTH.

ANTAGONIZING OR ARTICULATING MODELS.

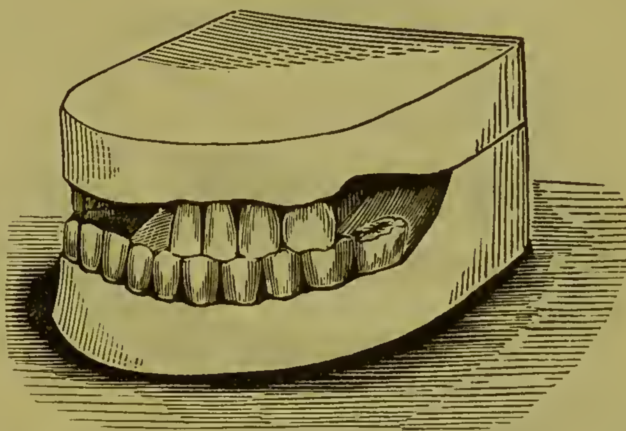
If the antagonizing model is required for only a partial upper denture—there being natural teeth in the lower jaw that antagonize with those which remain in the upper—it may be obtained in the following manner.

After having attached the clasps to the plate, it should be placed in the mouth, a rim of softened bees-wax being attached to it at the points where teeth are required; the patient is then requested to close the mouth *naturally*, imbedding the teeth of the lower jaw in the wax. While the mouth is thus closed, the wax on the outside of the teeth and alveolar ridge is pressed closely against them. This done, the plate and wax impression are carefully removed and placed on a piece of wet paper, with the wax downward. The upper side of the plate is then oiled, and covered with thin plaster. As the plaster stiffens, it may be applied until it is raised half an inch above the plate, and extended back of it on the paper an inch and a half or two inches. As soon as the plaster has set, it may be neatly trimmed around the edges, and on the surface next the paper or table, behind the plate and wax, a deep transverse or **T** shaped groove should be cut, or several conical depressions, three-eighths of an inch deep, to serve as moulds for the formation of corresponding ridges or protuberances on the half-model with which this is to antagonize.

This grooved surface must be coated with oil, or soap-water, or varnish, or a layer of thin tin-foil or thin paper. Then partly fill the space enclosed by the ridge of wax, with clay, putty or wet paper, and pour on plaster to form the other half-model. In running plaster into the wax impressions of the teeth, be very careful to avoid air bubbles and flaws, and do not oil the wax. After the plaster has set, it may be trimmed as before directed. When it has become sufficiently hardened, the two pieces may be separated after softening the wax in warm water,

and the wax and plate carefully removed. The model is now varnished, and when put together will present the appearance exhibited in Fig. 221.

Fig. 221.



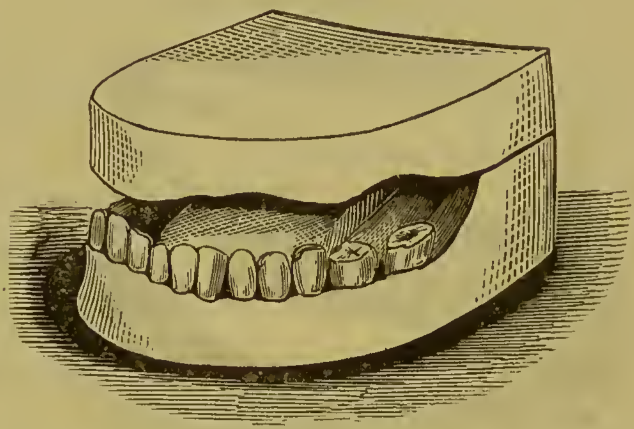
By this simple contrivance, an exact representation of the manner in which the jaws meet, is obtained, and the most simple, accurate and convenient antagonizing model procured that can possibly be made; provided with this, the dentist is prepared to select, arrange and antagonize the teeth. But when several natural molars and front teeth antagonize with those below, Prof. Austen's method may be adopted: which is to take a wax impression of the lower teeth. The model from this will articulate with the teeth of the upper model just as the natural teeth do.

When the antagonizing model is designed for a complete upper denture, a piece of wood, equal in width to the length required for the artificial teeth may be passed through the wax, after it has been arranged to the plate, at a point corresponding with, and in the direction of, the median line. The plate may then be placed in the mouth, and the patient directed to close the jaw *naturally*, until the teeth of the lower jaw come in contact with the wood. Then press the wax against the outside of the lower teeth and remove the plate with the adhering wax impression of the lower teeth. This done, the two halves of the articulating model may be made in the manner before directed. When completed, it will present the appearance represented in Fig. 222.

An antagonizing model may also be made by adjusting a rim of wax to the plate corresponding in width to the length pro-

posed for the artificial teeth, and trimming it until all the teeth in the lower jaw touch it at the same instant. This done, the plaster is applied as before directed.

Fig. 222.



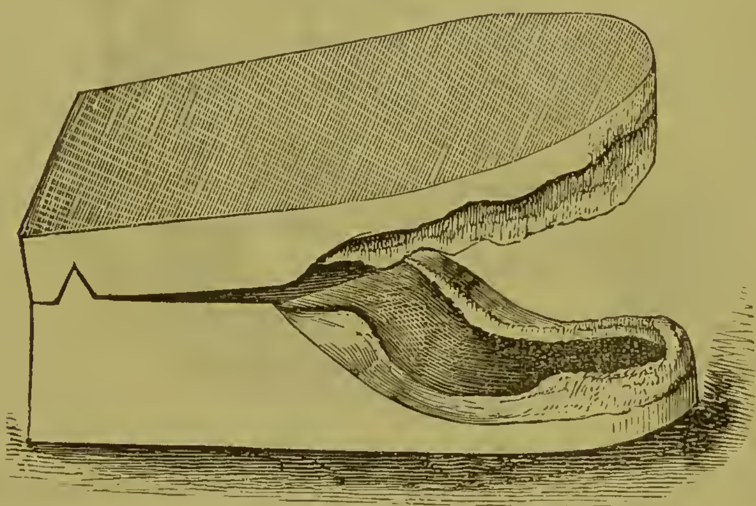
But a better plan than either of these is to adjust a rim of gutta-percha, which shall represent the required length and external fullness of the teeth. When this is satisfactorily adjusted, a small rim of soft wax is placed on the gutta-percha, and the mouth closed as naturally as possible until the teeth touch the latter. The gutta-percha can be readily trimmed with a sharp knife, and gives opportunity to ascertain, by the effect on the expression of the lips, &c., exactly what length and fullness of tooth suits the particular case.

There is a tendency on the part of the patient to close the mouth to one side and too far forward; it is impossible to close it behind the natural articulation. The simplest method for regulating this is to keep the body erect and throw the head backward, so as to make as tense as possible the throat muscles which thus act as a bridle, and almost compel a correct closure of the mouth.

In making an antagonizing model for a complete denture, or double set of artificial teeth, the following is the method very often adopted. After having fitted accurately both plates, a rim of soft bees-wax is placed between their convex surfaces, about an inch and a quarter in width. A piece of soft wood, exactly corresponding in width to the length it is designed that the upper and lower central incisors together should have, is passed through the wax between the plates, at the median line. The whole is now placed in the mouth of the patient, and each plate accurately adjusted to the alveolar border. The patient is then directed

to close the mouth naturally until the plates are brought in contact with the edges of the interposed piece of wood. This done, the plate, wax, and wood are removed from the mouth together, and a plaster model (Fig. 223) obtained in the manner before described.

FIG. 223.



But a far better method of making an antagonizing model consists in placing a rim of wax or gutta-percha on each plate giving the length, outline, and fullness respectively designed for the teeth of each jaw. The two plates are put in the mouth, and the jaws are carefully closed; if the rims of wax touch at any one point sooner than another, the plates are removed, and the wax trimmed; this operation is repeated until the two rims of wax meet all the way round, at the same instant, and give the proper contour to the cheeks and lips. The median line is then marked, and the final closure of the mouth made with the utmost care, so that there shall be no lateral or forward deviation. The exact position being secured, the lower jaw is to be held with the left hand, whilst, with the right, some eight or twelve deep indentations are made with a wax-knife, across the line of contact between the two rims. The pieces may be removed separately from the mouth, and can then, by the aid of these marks, be accurately readjusted. The two halves of the articulating model can then be made as previously directed.

To save plaster, and also, to permit modification of the articulation where inaccuracy is suspected, quite a number of frames have been devised—technically termed *articulators*. One

of the first ever contrived for this purpose, was by Dr. T. W. Evans, of Paris. It is made of heavy brass wire, and presents when the plaster models are attached, the appearance seen in

Fig. 224.

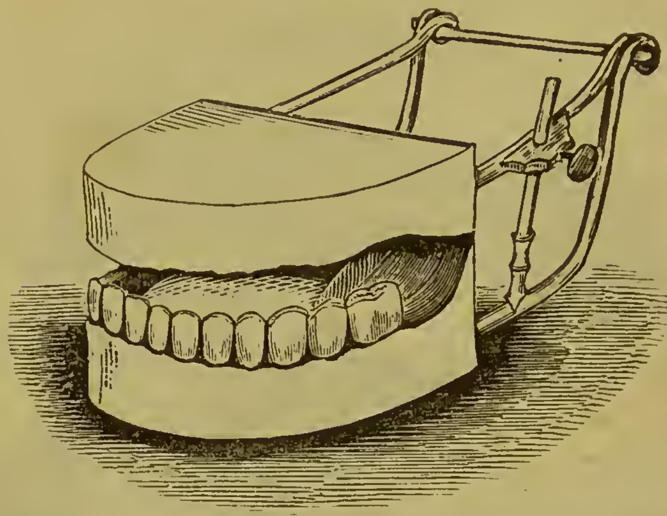
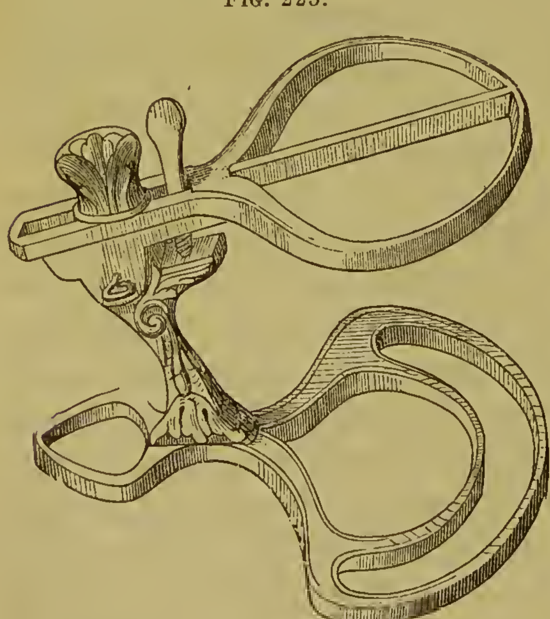


Fig. 224. The part embedded in each model, is a semi-circular continuation of the wire.

The articulator devised by Dr. W. H. Smith, Fig. 225, will be found to be one of the best in use. But when plaster is abundant there is no articulator better than the plaster one. It admits, however, of only one modification in case of an inaccurate antagonism, namely, widening. A careful manipulator never has occasion to alter his articulation. If modern *improved* articulators gave less facility for doing so, operators would, perhaps, be a little more careful, in this very important step in the construction of a piece of dental mechanism.

Fig. 225.



CHAPTER TWELFTH.

ADJUSTMENT OF PORCELAIN TEETH TO THE PLATE—FINISHING PROCESS.

Where a vacancy requiring only one or several teeth, is to be filled, it is highly important that the artificial teeth correspond in shade and color with the natural organs; for in proportion as they are whiter or darker, will the contrast be striking, and their artificial character apparent. Of the two faults it is better that they should be a little darker than any whiter. Their outer configuration should resemble, too, the shape of those which have been lost, so far as it is possible to ascertain this. Minute accuracy as to shades of color, involves the necessity of a large assortment, unless one is located near a depot or agency. But the facilities of mail and express companies will lessen this necessity, provided there is time to send for the tooth or teeth required. It is desirable, in view of this method of matching shades of color, to keep all refuse or broken teeth, as samples in sending orders.

The manufacturers supply three kinds of plate-teeth—plain, gum and sections. The latter have the advantage of showing few joints; but are less easily repaired, and are not applicable to so wide a range of cases. Gum teeth are applicable only where there has been sufficient absorption to permit the extra-fullness of the artificial gum. Many mouths are deformed by a foolish craving on the part of the patient for "gums," which the dentist should not be so foolish as to yield to, when plain teeth will make a far more natural piece. In point of strength, durability and facility of repair, plain teeth are superior to the others: they are also more readily adapted to the plate.

When selected, they should be arranged on the plate, and retained in place by a piece of wax placed on it behind them. If they do not fit closely to the plate or gums, they must be ground on emery or corundum wheels until accurately fitted, and so arranged as to meet the teeth with which they are intended to antagonize, at the same instant around the entire arch in full cases; in partial cases the natural teeth should touch their antagonists more decidedly than the artificial ones. A correct

antagonizing model will enable the dentist to do this with the most perfect accuracy.

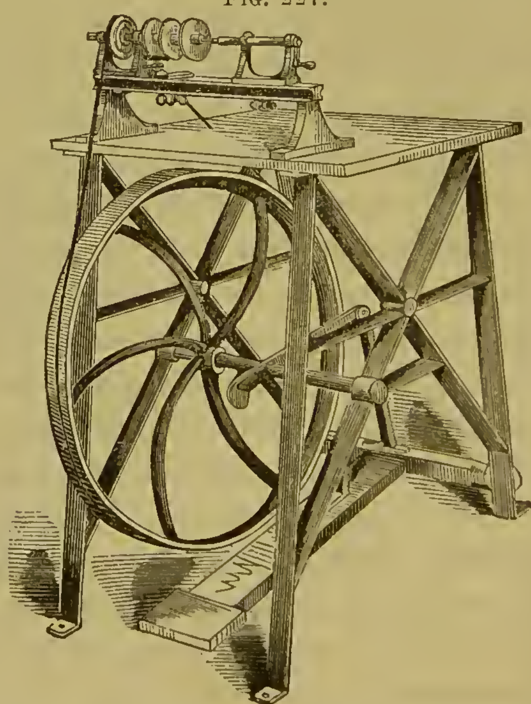
In arranging an entire set for the upper, or for both jaws, the molars are to be so adjusted that the inner or palatine tubercles of the upper strike the depressions in the lower, before the outer tubercles come together. This precaution is necessary, in antagonizing single as well as block teeth. If the outer tubercles strike first, the pressure there will spring and loosen the plate. For the same reason upper molars and bicuspids should not be set, if it is possible to avoid it, so that the force of mastication falls outside of the ridge. A small space, too, should be left between the last tooth of the upper and of the lower jaw, provided the crown of the lower molar, as sometimes happens, looks forward, its posterior edge being a little higher than the anterior.

It is often necessary to cut away a considerable portion of a tooth in order to make it fit accurately to the plate. This will make the process of grinding very tedious unless the operator has a number of sharp-cutting corundum wheels, varying from half an inch to three or four inches in diameter.

These may be attached to one of the hand lathes on page 615, or to one of the foot lathes, of which the depots now furnish

Fig. 226.

Fig. 227.



some excellent varieties. Fig. 226 represents an admirable lathe for dental purposes. While in Fig. 227, we have a larger,

stronger, and more powerful lathe, capable of very rapid motion, also adapted to the making of small instruments, handles, &c.

Those who have laboratory and office in one room, may wish to unite the ornamental and the useful. Figs. 228, 229, repre-

Fig. 228.

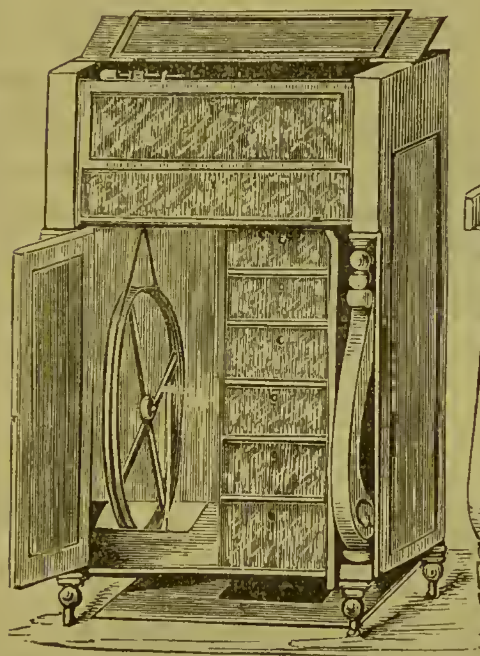
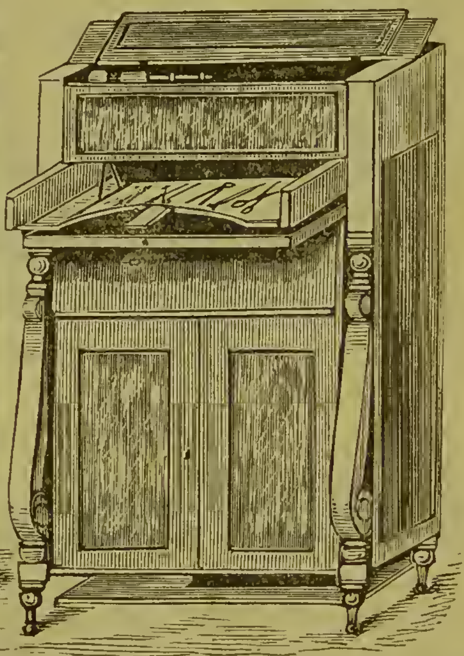


Fig. 229.



sent a piece of cabinet furniture combining lathe, work table, and drawers for implements, materials, &c.

Wheels may either be set at intervals on a long spindle, (Fig. 226,) or screwed singly on the end of the mandril. (Fig. 227.) In the latter case they should be fixed with a screw chuck in the centre, so as to be quickly changed from coarse to fine or from large to small. In grinding, the wheel should revolve toward the operator, and be kept constantly wet with a sponge held either in a sponge-holder, or between the ring finger and little finger of the left hand.

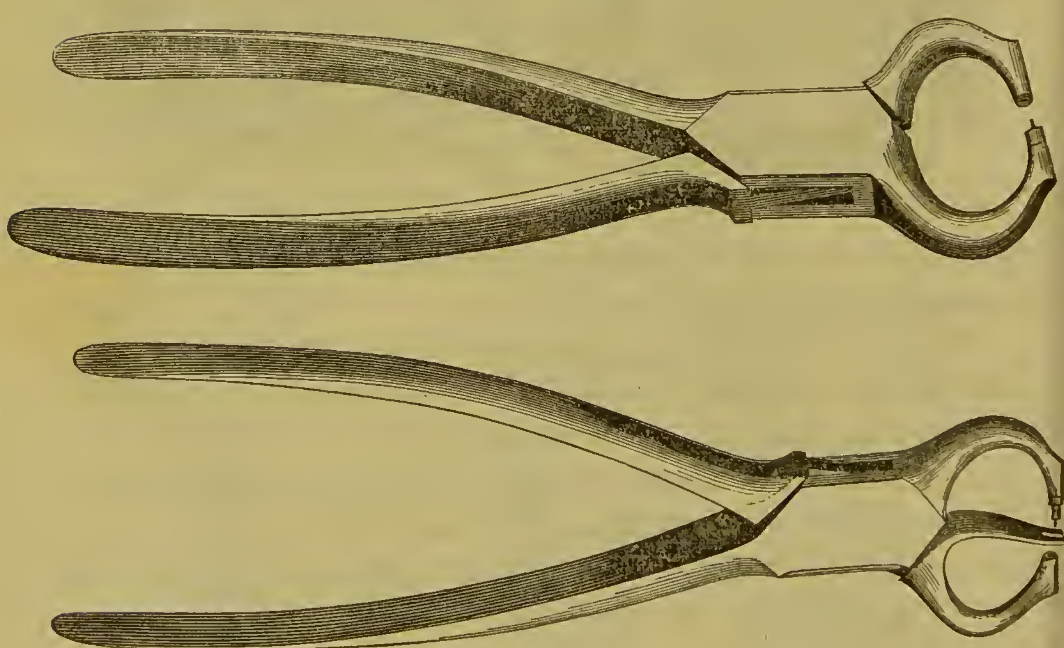
The thumb and forefinger of each hand must be free to hold the tooth, the right wrist being steadily supported on the hand rest. Two faults are very common in grinding: one is revolving the wheel too rapidly, the other, bearing the tooth too heavily against the wheel. The first hinders rather than helps grinding; the second is very apt to throw the tooth from the fingers,

and destroys the delicacy of touch necessary for accurate grinding.

In grinding blocks and gum teeth, and often in plain teeth, very small wheels are required to make them fit the curves of the plate. Thin edges of gum teeth and blocks must be ground with very fine grained wheels; whilst in jointing them a three inch wheel should be used, perfectly flat on its outer side, and running very true.

The teeth being thus arranged and adjusted, a gold plate, or backing large enough to cover the entire width and from eight to nine tenths of the height of the posterior surface of each, is fitted to them in the following manner—Each tooth has securely fixed in the back part of it two platina rivets, for the purpose of connecting it to the backing. Each backing, therefore, should have two holes punched through it, by means of a pair of dentist's punch forceps, like those represented in Fig. 230, large enough

Fig. 230.



to admit the rivets of the teeth. After having punched one hole, a rivet is inserted; then, by moving the strip of gold plate two or three times to the right and left, a mark will be left upon it, indicating the distance the rivets are apart. But previously to this the rivets should be made parallel, (being very careful not

to strain them in the tooth,) and the ends filed off level. Otherwise the pins will not go into the holes punched, and there will be an uncertainty as to which side of the pin the mark on the plate corresponds.

Dr. Samuel Mallet has very ingeniously invented a punch which will save much trouble in finding the proper position of the second hole. (Fig. 231.) After straightening the pins, one is placed in

FIG. 231.

the hole *i*, at the head of the punch, the other pin pressing out the movable punch *e*, (which works by the spring *g*,) until it slips into the slot *h*: the two punches *f*, *e*, then make the holes at the exact distances apart to receive the pins.

The holes should be slightly countersunk on both sides, and after placing the backing on the tooth, it is made fast by splitting with a strong knife or a wedge-shaped excavator, the ends of the platina rivets, or pinching them together with pliers. If the ends of the platina rivets are hammered so as completely to fill the holes in the backings, it will prevent the solder from flowing in and uniting the two as firmly as it should do. The backings may be slightly hollowed before they are put on. By doing this they will fit up closely to every part of the back of the tooth.

After the backings have been made fast to the teeth, they are to be accurately fitted to the plate, standing off from the plate enough for a very thin piece of watch-spring to be passed under. This makes it certain that the tooth is not raised by the backing from its place in the investment. A much wider space makes the flow of solder uncertain; and the practice of placing scraps of gold under badly fitted backings is a very slovenly one.

Some dentists back the teeth as they grind and fit them, and

before investing. Others invest with the soldering mixture, and back without taking them from the investment. Others, again, partially invest with the soldering mixture, remove and back the teeth; then replace and add more plaster and sand (or asbestos) over the edges of the teeth. Professor Austen's method is thus described—"Fasten each tooth or block, as it is ground, to the plate with wax, placing tissue paper between the lateral joints of gum or block teeth, to prevent actual contact (which sometimes causes splintering of the gum upon the contraction of the plate after soldering). The grinding and articulating done, place the half-model of the articulator, back downward, with plate and teeth upon it, upon the plaster table. Around the outside of the teeth, plate and articulator (slightly oiled, or soaped), run a band of pure plaster from one fourth to one half an inch thick. When hard, the wax is to be removed from the teeth, and each tooth or block taken out separately and backed.

"The different modes of backing I shall not here describe further than to refer to the two classes: 1, those temporarily fastened to the teeth and soldered to teeth and plate at the same time; 2, those soldered to the teeth and finished up before being soldered to the plate.

"Sometimes the shape of a gum or block tooth may require the removal of the plaster rim, which can be detached either in one, two or three pieces, and readily replaced after the backing is completed, for the final adjustment of the teeth. The teeth are next to be fastened to the plate with a small quantity of cement (resin, mixed with wax, or still better, with gutta percha and plaster), and a small roll of softened wax (not melted or made adhesive) placed over the entire surface to be soldered. The plaster rim is then very carefully removed, and the piece surrounded with the soldering investment, which must be no thicker than is sufficient to protect the teeth and hold them in place. The wax and cement can be very quickly removed, leaving the surfaces perfectly clean and ready for the borax and solder. The investment should not cover the lingual surface of the plate, nor should it be thick on the palatine surface; on which side it would be well also to cut along the median line nearly or quite through the investment. The object of this is to give play to the *lateral* expansion of the plate; the antero-posterior expansion being

usually, from the shape of the plate, sufficiently free. This I regard the simplest and best method to prevent warping of the plate, so often caused by the very means taken to prevent it.

"I have said nothing of fastening the teeth so as to try them in the mouth before soldering, because a correctly taken articulation makes it unnecessary. Those who prefer to do so can secure the teeth with cement (resin and gutta-percha) instead of wax after grinding; or, perhaps better still, after making the temporary plaster investment, unless much alteration is necessary."

Mr. Andrew Wilson, of Scotland, adopts the following method of backing teeth: "After having *partially* fitted the tooth to the plate, take a piece of platina foil, as thick as can be used conveniently, and pressing it against the back of the tooth, perforate it where it is marked by the pins; then cut it into the required shape of the backing, and press it as closely as possible to the back of the tooth.

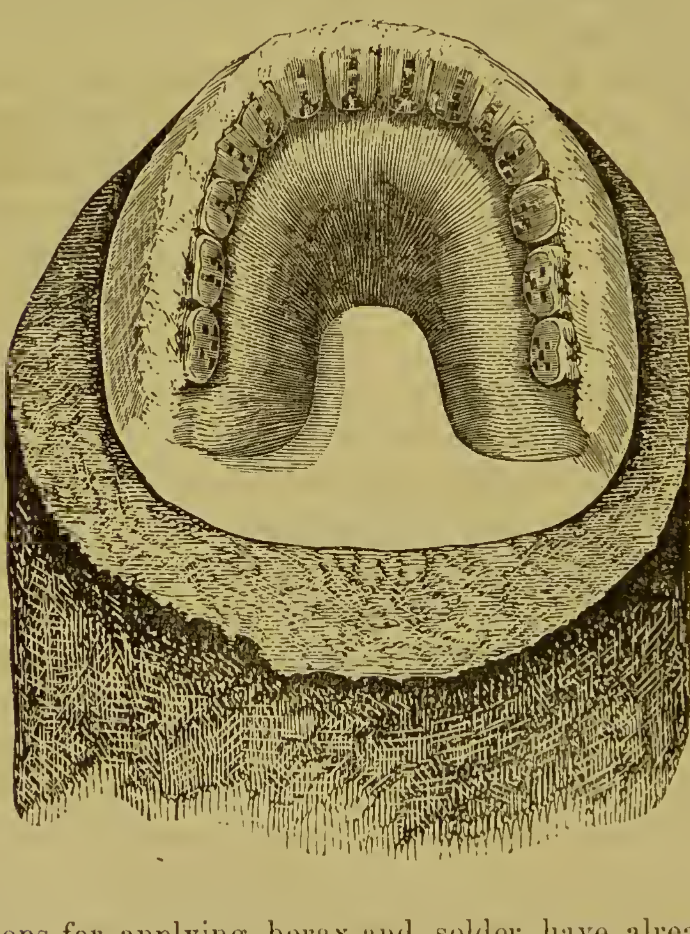
"It will now be requisite to apply a little borax to the platina pins which come through the back, and placing the tooth with its face downward upon a thin piece of pumice, covered with dry plaster of paris, put several pieces of gold (according to the thickness required) upon the platina back; slowly heat it, gradually raising the heat till it is considered safe to melt the gold with the blow-pipe, when, upon continuing the blast, the gold will rapidly flow over the whole platina surface, uniting so firmly with the pins in the tooth, that I have never, during eight years' use, seen a case in which they have loosened, even where there has been sufficient violence to break the tooth.

"After the backing has been run, and the tooth allowed to cool slowly, it is filed to the requisite thickness and shape; tooth and backing are then closely fitted and finally soldered to the plate. In arranging the teeth on the plate for soldering, I use a mixture of equal parts of white sand and plaster, placing a thin strip of platina on the outside of the teeth, with a layer of the above mixture on both sides of it, so that should the plaster crack in soldering, (although it is less liable to do so than plaster alone,) the platina may keep the teeth from shifting their places. The whole time occupied in heating and backing a tooth is about half an hour, and when several are done at once, a little longer."

Instead of using the strip of platina plate to prevent the teeth from becoming displaced, in case the plaster cracks, thin sheet iron or iron wire may be used; but platina is undoubtedly the neatest and has the advantage of being indestructible; it may be narrow and thin, so that its cost would form no objection to its use. Mr. Wilson's method might be improved, first, by completely fitting the tooth before backing; secondly, by running the thin platina slip, one eighth of an inch down on the plate, to any irregularities of which it can be quickly burnished down by making several slits in the edge. This would secure a very perfect and strong attachment to the plate.

A piece invested preparatory for soldering and placed upon a lump of solid charcoal, is seen in Fig. 232.

Fig. 232.



Directions for applying borax and solder have already been given. Some cut the solder into very small pieces; others use one piece to each tooth at its base, and a second for the pins unless previously soldered. If the backings are soldered to the

teeth beforehand, a more fusible grade of solder should be used at the second soldering.

The work, as before stated, must be gradually and thoroughly heated up before directing the flame upon the plate or backings. The last point to be touched with the flame is the solder, and this not before a slight melting of the edge shows that it is just on the point of flowing. If every preparation for soldering has been properly made, the actual flowing of the solder on a full piece will take less than a minute, and will be so smooth as to require no other finish than the Scotch-stone, and polishing wheels. The soldering being completed, the cover should be placed upon the soldering pan, (Fig. 220,) and the work allowed to become quite cold before removal.

FINISHING PROCESS.

As soon as the piece has cooled sufficiently, after the process of soldering is completed, the plaster is carefully removed from the teeth; the piece is then placed in a glass or porcelain vessel containing a mixture of equal parts of sulphuric acid and water, and heat applied. As soon as the borax (which, by the process of soldering, has lost its water of crystallization and assumed a glassy hardness) is decomposed, the vessel is removed and allowed slowly to cool. This process is termed by jewelers, pickling, and requires from ten minutes to half an hour for its completion, according to the strength of the acid and the quantity of vitrified borax on the plate. After this is decomposed, the acid is washed from the piece, which can be more effectually done by the use of heat and a little caustic soda.

In removing the roughness which may have been occasioned by the imperfect fusion and unevenness of any of the pieces of solder, or from its flowing in a wrong direction, care must be taken not to cut away too much of the plate. For this purpose scrapers, files and lathe-burs are used, according to the position and quantity of surplus solder. After the work has been made as smooth as possible with scrapers, &c., it should be rubbed with pieces of Scotch-stone and water until every scratch is removed, and then polished with tripoli, applied by means of oil or tallow to a brush wheel, (Fig. 233,) which is made to revolve rapidly

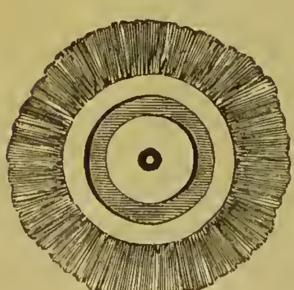
against the work. As to the rapidity with which a lathe should be worked—drills and burs require a slow movement, corundum wheels a quicker one; rotten-stone a rapid motion, and whiting or rouge the most rapid of all.

The pieee may now be placed in a porcelain vessel containing the following mixture: nitre, two ounces, salt and alum, each, one ounce—dissolved in four ounees of water. After boiling for half an hour in this, to deeompose the copper from the surface layer of the solder and plate, it is boiled a few minutes in a mixture of four ounees of water, with one ounce of eaustie soda, for the purpose of neutralizing the aeid formed by the first mixture, then washed with a brush in pure water.

The removal of the eopper from the surface of the plate, gives to the gold the beautiful orange hue, whieh is its natural eolor, and which it will retain until the frietion of mastieation wears off this surfaee. The secretions of the mouth will fail to tarnish it; and it will be free from the disagreeable taste of whieh so many eomplain, who wear artifieial teeth set on metallie plate.

The process of finishing may be eompleted by polishing every part of the lingual surfaee of the plate, baekings, and clasps, with highly tempered and finely polished steel burnishers, or with rotten-stone and *jeweler's rouge.** If burnishers are used, they should be frequently dipped in a mixture of water and eastile soap; they should be rubbed backward and forward in the same direetion, until every part of the gold exhibits a high polish. Burnishers of different shapes may be required for different parts of the work: bloodstone burnishers are also used.

Fig. 233.



A large piece, however, can be polished in much less time, if not more perfectly with a revolving brush, like the one represented in Fig. 233. The brush should be set on the spindle of the lathe, then lightly smeared with suet, by holding a small piece against it while it is revolving. The rotten-stone is applied in the same

* *Jeweler's rouge* is made by dissolving copperas in water, filtering the solution, and adding a filtered solution of pearlash or subearbonate of soda, as long as any sediment falls. The liquor is again filtered, and the sediment left on the filter washed by running clean water through it, and then calcined until it is of a scarlet color.—*Chemistry of the Arts*, vol. 2, p. 529.

manner, and with the brush thus charged, the polishing may commence, but the plate must not be exposed too long to the friction, as it will rapidly wear away the pure gold surface brought out by the pickle. Some use only the burnisher or rouge after pickling. Tripoli has a sharper grit and cuts more rapidly than the ordinary rotten-stone prepared for daguerreotypists' use, but the latter gives a very smooth surface, and will, in most cases, give a sufficiently brilliant finish without rouge.

But a very high "watch-case" finish can only be given by the very rapid revolution of wheels or buffers, charged with finest quality of rouge, wet with alcohol. The piece must be previously washed with soap and water, so as to remove every trace of oil. Sometimes the rouge is applied on a piece of soft buckskin, wrapped or sewed around small blunt-pointed pieces of wood.

Upon the insertion of partial pieces with clasps prepared in the manner just described, it may possibly become necessary to make some little alteration in the adaptation of the clasps. This, the operator can do, with a pair of common pliers; and it should be borne in mind that clasps must never be so applied as to prevent the patient from removing and replacing the piece at pleasure. He should be directed to do this two or three times every day, and each time, to clean thoroughly the teeth to which the clasps are applied, and it may be advisable for the artificial piece to be taken out every night on going to bed, and remain out until morning. This should also be done with pieces, whether partial or entire, which depend for their adhesion upon a vacuum cavity, so as to give rest to the mucous membrane and permit the swelling opposite the cavity to subside. But pieces that are retained, simply, by the accuracy of their adaptation may be worn night and day, and this will ordinarily be found most agreeable to the patient.

A beautiful style of tooth made by Ash, of London, is secured to the plate by gold pins, fastened to the teeth by hard-solder, and then secured by soft-solder to the gold tube running through the axis of the tooth. The composition of the tooth renders this modification in the mode of attachment necessary, as they will not stand a soldering heat.

A substitute for the incisors and cuspids, thus mounted, is

represented in Fig. 234, copied from the work of Dr. James Robinson. This engraving will convey a sufficiently correct idea of the method of attaching the English mineral or porcelain teeth to a metallic base, to render any other description unnecessary. The fastening by pins will prove serviceable for blocks; but for single teeth, metallic backings, riveted and soldered after the American method, as above directed, is a far more secure method of attachment.

Fig. 234.

As the improvements in ceramic dentistry have so entirely superseded the use of natural teeth, and since these are open to serious objections, previously stated, it is not thought necessary to give any description of the methods once employed for mounting them. We shall next proceed to notice the manner in which artificial substitutes are retained in the mouth: also some of the modifications of form, &c., required by the special conditions of individual cases; giving a sufficient variety to prepare the student for any case that may come before him.

CHAPTER THIRTEENTH.

ARTIFICIAL TEETH RETAINED BY SPIRAL SPRINGS.

A DOUBLE set of artificial teeth (by which is meant a substitute for all or the greater part of the natural teeth of both jaws) was at one time universally, though now very rarely, retained in place in the mouth with spiral springs. When correctly constructed, and applied under favorable circumstances, they are valuable substitutes for the natural organs; but when badly constructed, and applied under unfavorable circumstances, they are productive of more or less inconvenience and annoyance to the patient.

It often happens that the loss of the teeth is occasioned by disease in the gums and alveolar processes; in which case, the latter are so much wasted and destroyed that the ridge is scarcely perceptible, and is sometimes, in the lower jaw, covered with loose folds of mucous membrane. The pressure of spiral springs upon these folds is apt to produce irritation; so that it is very difficult to give to lower pieces, in such cases, much stability. This total, or almost total, absence of any alveolar ridge in both upper and lower jaws is regarded by many as demanding the use of spiral springs. In some upper cases the palatine arch is a plane from one side to the other, and in a very few it is actually convex; the attachment of the muscles being so close down upon the edge of the alveolar border as to permit scarcely any plate to be turned up. The great difficulty in the way of securing such plates by atmospheric pressure, is the almost impossibility of preventing lateral motion. A sharply defined vacuum cavity will sometimes meet the difficulty; but all mouths will not bear the irritation of this, and there is no alternative but to use spiral springs.

A more modern application of spiral springs is their temporary use in pieces made very soon after the extraction of the teeth. The dentist not wishing, for several reasons, to conform

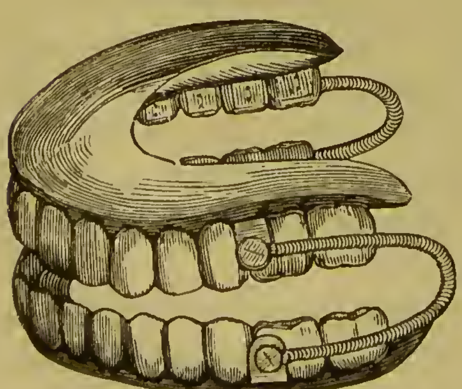
the plate to all the irregularities of the gum at this stage of absorption, pares down on the model the prominences, and fills up the hollows of the ridge. This necessarily destroys the fit of the plate, and the pressure of springs is necessary until the mouth has, by absorption, adapted itself to the plate: they may then be taken off.

The upper plate may be about one inch in width, and made of twenty-carat gold; the lower should be as wide as the ridge will admit of its being made, and twice as thick as the upper, and the gold at least twenty-two carats fine.

After having obtained a correct antagonizing model, the operator places on each plate a rim of bees-wax, against which the teeth are arranged as he selects them; beginning with the central incisors, he may adapt first the upper, then the lower, next the laterals, afterward the cuspids and bicuspids, and, lastly, the first and second molars—twenty-eight being the number usually employed for an artificial set. After the teeth have been ground, arranged, and fitted to the plates, the gold backings are to be attached, and the piece then invested with plaster; the wax is next removed, and the process of soldering and finishing performed in the manner already described.

But before the teeth are soldered on, the attachments or standards for the springs are made fast to the outer edge of the plates on each side, resting against the second bicuspids, or partly between them and the first molars. The kind of attachment which the author prefers, so regulates the motion of the springs, that they are prevented from coming in contact with the outer surface of the alveolar ridge beyond the plate, or from turning out toward the cheek, and irritating the mucous membrane. The construction of the standards, eyelets and spiral springs is so plainly exhibited on the next page (Fig. 236), that any verbal description is deemed unnecessary.

Fig. 235.

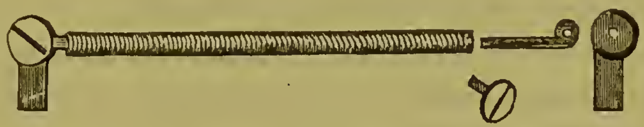


The manner in which the springs act may be seen in Fig. 235, by which it will be per-

ceived the upper and lower dentures are constantly, but gently pressed against the parts on which they rest.

Spiral springs are most conveniently purchased at the depots; but they may be made by the simple apparatus shown in Fig. 187. The length of the springs must be determined by the

Fig. 236.



distance of the jaws from each other when the mouth is opened; it being in some cases necessary to have them much longer than in others. The usual length, however, is from an inch and a half to two inches.

It often happens that six or eight teeth in the front part of the mouth, in the lower jaw, remain healthy and firmly fixed in their sockets, after all the other teeth are lost. In this case, the lower plate may be so constructed as to cover the vacant portions of the alveolar ridge, fitting its upper and inner surface behind the remaining natural teeth. This part of the plate is strengthened by soldering to it another plate of equal or even greater thickness.

But when the lower incisors, cuspids, and two of the bicuspids remain, it is perhaps better to dispense with the molars and remaining bicuspids, than encumber this part of the mouth with an artificial substitute. When there are but six teeth remaining in the lower maxilla, it is thought by some practitioners better to extract them and apply an entire denture, as it is sometimes almost impossible to replace the others in such a way as to render them serviceable while the front part of the jaw is occupied with natural teeth. The extraction of four or even six front lower teeth remaining, is perfectly justifiable under certain circumstances—where they are much decayed, or are elongated by ossific deposit, or loosened by alveolar absorption, or project outward so much as to make the articulation of the upper teeth very disfiguring. A partial lower piece can be made under these circumstances, and spiral springs attached if required; but the work will not give much satisfaction to the patient, or add much to the reputation of the operator.

ARTIFICIAL GUM-TEETH, SINGLE OR IN SECTIONS.

The loss of the teeth is followed, sooner or later, by the absorption of more or less of the alveolar border. Much of this absorption not unfrequently precedes the loss of the teeth; and in extraction it becomes at times necessary to destroy a part of the alveolus. In furnishing a substitute, therefore, for the teeth, it often becomes necessary, for the restoration of the contour of the face, to replace the missing alveolus: for doing this several methods have been adopted.

When ivory was employed for artificial teeth, as a base for the support of the teeth, it was carved in such a manner as to imitate the shape of the gums, and afterwards colored. But the use of hippopotamus teeth or elephant-ivory, for purposes of this kind, has been wholly or very nearly abandoned.

Raised plates—that is, plates made double over the ridge, with a space between—have also been employed, and these may be made to answer a very good purpose; but improvements in the manufacture of porcelain teeth have supplied a much better substitute for the alveolar border and gums. Porcelain teeth may be manufactured either singly or in blocks, colored and enameled on the exterior or labial surface above the tooth, so as to form a most excellent substitute for the lost structures, and imitating nature so closely as almost to preclude the possibility of detection. It is customary among dentists manufacturing their own porcelain or mineral teeth, to mould them in blocks of three, four or five teeth. Comparatively few dentists possess the necessary knowledge, practical experience, or apparatus for doing this; but there are some cases in which they cannot be advantageously dispensed with. In a subsequent chapter, the method of making and mounting block teeth will be described.

A practical knowledge of block carving is of great service to the dentist who has the peculiar talent which it requires, and the time at his command which its prosecution demands. But like the manufacture of single teeth, this is rapidly passing out of the hands of the professional man into those of the manufacturer. The consequence is that the variety and beauty of the blocks offered for sale are so rapidly improving, that the same

necessity is not felt as formerly to devote so many months to the study of ceramic dentistry. Teeth, with artificial gums to supply the alveolar loss, are made either singly or in sections of two, three or four.

A little more time and tact are required in fitting the single gum teeth to each other, and to the plate, than in adapting blocks or sections; but when properly adjusted and attached to the plate, they answer, in very many cases, almost as good a purpose; and if by any accident one or two of the teeth are broken, they may be more easily replaced. In the construction of a piece composed of single teeth, they should be fitted to each other and the plate in the most perfect and accurate manner, so that no lodgments may be afforded for particles of food or extraneous matter of any kind. One point, however, must be remembered, which has been already alluded to. In soldering, the metal expands, while the teeth held in the investment are brought closer together by its contraction, and in this slightly altered position they are soldered to the plate. The contraction of the plate on cooling is irresistible, and may result in one or both of two accidents—chipping off the brittle edges of the teeth thus brought too closely together, or warping the plate because of the resistance which the teeth or blocks offer to the contraction of the plate. The thinnest letter-paper slipped between the side joints will suffice to prevent these accidents. In Figs. 237, 238, are represented atmospheric pressure substitutes for all the teeth

Fig. 237.

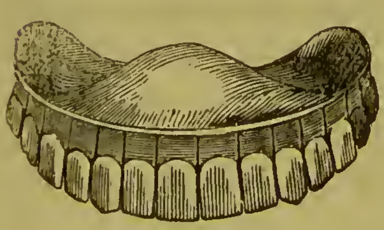
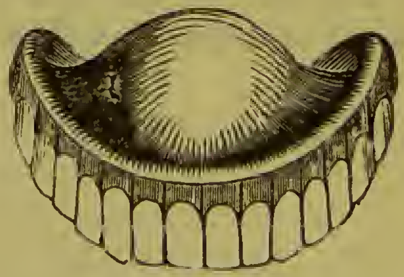


Fig. 238.



of the upper jaw, composed of single gum teeth, mounted upon broad plates. In the latter, the outer edge of the plate is turned down on the front edge of the gums, both for strength and ornament.

Usually, in first or temporary pieces, and sometimes after the alveolar absorption is completed, the fullness of the gum is such

as to forbid the addition of an artificial gum to the six or eight front teeth. In such cases the plate must be cut away from the front of the ridge as far as the first or second bicuspid, and the teeth ground with great accuracy to fit the gum itself. Single plain teeth will usually be best adapted to such cases; but an excellent effect can sometimes be produced by grinding a block, when the shade of gum is well matched, to fit directly upon the natural gum.

It has been also recommended to cover the anterior margin of the plate and interspaces between the teeth with a terra-metallic paste, fusible at a very low temperature, and afterwards covered with gum enamel. The following formula is given by M. Delabarre for this purpose: Porcelain paste 1 oz., white silex half oz., any oxide 10 grs., and a sufficient quantity of calcined gypsum, to give to it the necessary degree of fusibility. As a suitable enamel, Desirabode recommends, feldspar 2 drachms, oxide of gold 6 grs., kaolin 6 grs. But neither of these formulæ can be used on gold plate, nor in connection with American porcelain teeth, as too high a heat is required for their fusion. Drs. Hunter and Allen, however, have succeeded in making a silicious composition, which can be used on gold slightly alloyed with platina. That it is quite possible to make a porcelain enamel which will fuse below the melting point of even eighteen-carat gold is known to every jeweller. But the serious difficulty in all such enamels is their frail and brittle nature; hence none are now used to any extent except that form of enamel known as "Allen's Gum," or the "Continuous Gum," which fuses above the melting point of pure gold. This process will be described in the seventeenth chapter.

CHAPTER FOURTEENTH.

ARTIFICIAL TEETH RETAINED BY CLASPS.

In supplying the loss of natural teeth with artificial substitutes, the ingenuity and skill of the dentist are often taxed to their greatest extent. No two cases are precisely alike, and, therefore, no directions can be given upon the subject which it will not often be necessary to modify. The illustrations, however, which follow will, we trust, from their variety, enable the practitioner to construct an efficient and useful substitute for any teeth, the loss of which he may be called upon to replace.

POSITION AND SHAPE OF TEETH MOST SUITABLE FOR CLASPS —MEANS NECESSARY TO PREVENT THE INJURY RESULTING FROM THEIR USE.

Some teeth, owing to their situation in the dental arch and the shape of their crowns, offer a more secure means of attachment to a dental substitute retained in the mouth by clasps than others. In selecting those which are to be used for this purpose, the exercise of some judgment is often called for. There are many circumstances, however, which should influence the decision of the dentist in this matter. Some of these we shall now proceed to notice.

As we have stated in another place, the first molars in the upper jaw, when sound and securely articulated, offer a better means of support than any of the other teeth, and when they can be conveniently employed for this purpose, should always be preferred. But when, from loss, decay or defective shape, these cannot be used, the second bicuspids or second molars are to be preferred; the bicuspids having the advantage so far as regards position, but the molars being larger and firmer. Next to these in order of choice come the first bicuspids, which are inferior to the second, chiefly because they cannot be clasped so

fully without exposing the metal of the clasp. Unless large, sound and strong, the bicuspids should not be depended on for the retention of a large number of teeth; but for incisors alone, they are the best clasp-teeth, owing to their position. In this latter respect, the worst teeth in the mouth are the third molars. Their bad position, their liability to decay, and their frequent conical shape make these the most undesirable of all, except the six front teeth, for the attachment of clasps. Still, if sound, firmly articulated and well shaped, they may, as a last resort, be used.

The crowns of the cuspids being of a conical shape, are wholly unsuited for the retention of clasps, and, consequently, should never be used for this purpose. There are cases, however, in which it is considered by some to be absolutely necessary to apply clasps to these teeth; as, for example, when the loss of an incisor is to be replaced with a substitute attached to a narrow plate, and where none of the back teeth remain or are in a condition to be used as a means of support to the plate. In this case, the clasps should be narrow, and adapted with the greatest accuracy. This becomes the more essential, as it is necessary that they should be short to prevent being seen, and as no hold can be obtained upon the lingual side of the tooth. They should also be applied near to the gums, but not so near as to touch and irritate them, or the cementum at the neck of the tooth.

The incisors are, of all the teeth, the least suited for the attachment of a dental substitute. It is exceedingly difficult to apply clasps to these teeth in such a manner as to retain even a single tooth with sufficient stability to be worn with any degree of comfort. We remember once to have seen a case in which a central incisor (natural tooth) was inserted and kept in place by a gold wire projecting from each side of the tooth into holes drilled into the adjoining teeth. A stage of dental progress that permitted such a process, might also have allowed the clasping of incisors. But we know of no possible circumstances that will justify, in the present state of dental art, the clasping of the four (we were about to say the six) front teeth.

There are many circumstances, besides position and shape, which it is necessary to take into consideration in the selection of teeth to be used as a means of support for artificial teeth.

For example, a space should never be filed between two sound molar or bicuspid teeth for the purpose of applying a clasp, if there is another tooth around which it can be placed without this operation. The liability of the tooth to decay, around which a clasp is applied, is always greatly increased by the removal of any portion of its enamel; hence, the separation of two teeth with a file, with a view to the application of a clasp to one of them, should never be resorted to.

A clasp should never be applied to a loose tooth, or to one situated in a diseased socket, or which is so much affected by caries as to render its perfect restoration and permanent preservation impracticable; and when none but such can be had, the proper course to pursue is, either to extract every tooth in the jaw, and replace the loss of the whole with an entire upper set, or to replace the missing teeth upon an atmospheric pressure plate. The application of clasps to diseased or loose teeth always aggravates the morbid condition of the parts, and causes the substitute which they keep in place to become a source of annoyance to the patient. Besides, such teeth can be retained in the mouth only for a short time, and when they give way, the artificial appliance becomes comparatively or entirely useless; and even before their loss, it is not held firmly in its place, but is moved up and down by the action of the lips and tongue. Thus not only is its presence open to the observation of the most careless observer, but this motion is rapidly destructive to all the teeth near or against which the piece comes.

In the lower jaw, parts of sets are much less frequently called for than in the upper, and when they are, the use of clasps may be often dispensed with altogether. But it sometimes becomes necessary to use them, and, as a general rule, they can be more conveniently applied to the bicuspids than to the molars or cuspids. A clasp can seldom be applied advantageously to a lower molar. The lower front teeth are least liable to decay of any in the mouth, and, therefore, do not require replacement, except in full sets, unless lost by a blow or by the destructive action of salivary calculus. A partial lower front piece calls for clasps or stays; but other partial lower pieces (replacing bicuspids and molars) should not depend for their stability upon any remaining bicuspid or cuspid.

If the injurious effects liable to result from the application of clasps to teeth could not, in any way, be counteracted, dental substitutes, maintained in the mouth by this means, would, in the majority of cases, be productive of more injury than benefit. But, fortunately, they may, in most cases, to some extent at least, be prevented. They are not produced, as many have erroneously supposed, solely by the mechanical action of the clasps upon the teeth, but also by the chemical action of the secretions of the mouth and decomposing particles of food.

The cause of this destructive action, then, being chemical, as well as mechanical, the method of measurably preventing its deleterious effects is obvious, and is two-fold: First, to prevent the chemical action, the frequent removal of the artificial teeth, and thoroughly cleansing the natural organs used as a means of support for them. This should be done every night and morning, and after each meal. For which purpose, a brush and waxed floss-silk may be employed, and the teeth rubbed until every particle of clammy and vitiated mucus and foreign matter is removed. The inner surfaces of the clasps, too, should be freed from all impurities, and the whole piece cleansed with a brush and water. Secondly, to prevent or lessen the mechanical action, the clasp should fit with great accuracy and around the parts of the tooth protected with hard enamel; and the whole piece should have such an accuracy of adaptation as to prevent that motion of the clasp which inevitably gives rise to a destructive friction upon the tooth. We have elsewhere spoken of other injurious consequences of fitting clasps imperfectly or placing them close upon the gums or exposed necks. Rapid decay and breaking off of the teeth, inflammation of the gums, of the alveolo-dental periosteum, destruction of the alveoli, and loosening of the teeth are among the common results of the clasping of teeth as it is too often practiced. Consequences which have led many to too unqualified a condemnation of this method, which, in certain cases, is, if properly executed, the best and most durable way in which a partial piece can be secured.

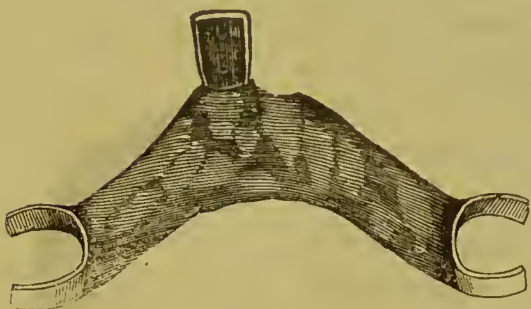
CENTRAL INCISOR WITH ONE CLASP.

The usual method of applying a central incisor on a metallic base consists in extending the plate over the palatine arch to the second bicuspid or first molar on each side of the mouth, and securing it in the mouth by two clasps; but it is not always necessary to do this. It can often be securely and firmly fixed by extending the plate back on one side only, and clasping it to a single bicuspid or molar. A piece secured in this manner may be frequently worn with comfort and satisfaction for years. The author has very frequently applied one tooth in this way, when he found it necessary to use clasps, and even two teeth may often be securely retained with one clasp. In extending the plate over the arch of the mouth, it should never be fitted closely around the necks of the teeth behind which it passes, for the reason that it is liable to irritate and inflame the apices of the gums, and to irritate also the sensitive neck of the tooth, and sometimes even the alveolo-dental periosteum. The author, in common with other dentists, was in the habit of doing this for a long time; but, observing the bad effects produced by it, he abandoned the practice many years ago, and has since, in nearly all cases, left a space of never less than an eighth of an inch, and often much more, between the plate and the teeth behind which it passed. A correct idea may be formed of the manner in which a central incisor is thus arranged by an examination of Fig. 239. It will be seen that the lateral curve of the plate is in the opposite direction from the curvature of the dental arch, thus giving proximity to the teeth only where it is unavoidable. A lateral incisor, cuspid or bicuspid may be applied in the same way; and if the second bicuspid or first molar is unfit, from its shape or from decay, to be clasped, the plate may be extended to the second molar, or it may be even carried across the mouth, and clasped to a tooth on the opposite side.

Fig. 239.

CENTRAL INCISOR WITH TWO CLASPS.

Fig. 240.



Cases will frequently occur in which it may be necessary to employ two clasps for the support of a single incisor. The accompanying cut (Fig. 240) will indicate the description of plate most proper to be used. The plate, as here shown, is extended back to the first molar on each side, to which it is secured by suitable clasps. When two clasps are used, it is not essential that so much of the tooth should be grasped by the clasp. In some cases, the piece will be firmly retained by short clasps, bearing against the lingual third of the tooth, provided the surface is so shaped as to allow their retention. Such partial clasps are called stays, and are often used in connection with an atmospheric-pressure plate to prevent lateral motion.

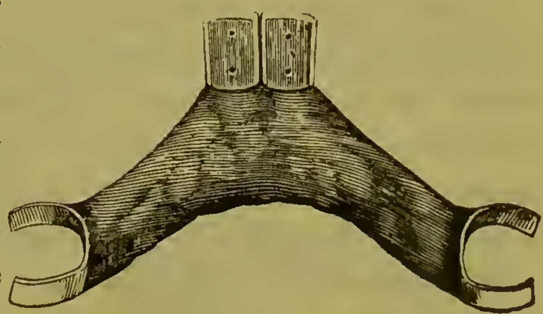
When the patient is very intolerant of the presence of much metal in the mouth, one or two teeth may sometimes be securely inserted, as suggested by Dr. Maynard, upon a T-shaped plate. The cross-piece one-fourth to three-eighths of an inch wide, fitting the arch from bicuspid to bicuspid; the slip to which the tooth is attached being soldered to the centre, and also fitting the arch. Such a piece, well made, will resist considerable traction upon the incisor. Owing to the peculiarity of its shape, the attempt to draw down the tooth springs the transverse slip of metal, and causes it to bind upon the bicuspids.

TWO CENTRAL INCISORS WITH CLASPS.

In the application of the two upper central incisors on plate, two clasps, one on each side, will ordinarily be found necessary, although they can sometimes be securely and steadily held in place with one. The shape and general arrangement of the plate is the same as in the last case, but it should be a little wider on account of the increased strain caused by the additional tooth.

The second bicuspids or first molars are the most suitable teeth for clasping, so far as regards position; but if caries, or defect in shape, or the absence of these teeth prevent their use, the first bicuspids or second molars must be used, whichever may be best suited to give a firm support. In Fig. 241 the plate is represented as extending to the first molar on each side.

Fig. 241.



It not unfrequently happens that one or two inferior incisors are missing—the result either of accident, or from absorption of the alveoli. They may be replaced by attaching the artificial teeth to a narrow plate, shaped somewhat as in the upper jaw, and clasped to a bicuspid or molar on each side. The plate in this case must necessarily come close to, and sometimes even rest against, the inside of the lower teeth. Unless it fit with great accuracy and is firmly secured, such a partial lower piece is very apt to cause irritation, disease and absorption of the gums and alveoli over which it passes.

INCISORS AND CUSPIDS WITH CLASPS.

The construction of the plate represented in Fig. 242 is upon precisely the same principle as the preceding, the only difference being that the part of the plate on which the teeth are mounted fills a larger vacancy in the alveolar arch. As in the former case, when the teeth on one side of the mouth are too much decayed, or are incapable of affording a secure attachment, or are missing, even this number of teeth may be held by one or two clasps on only one side of the mouth; but whenever this is done, the plate should be extended half or three-fourths of an inch back of the tooth to which it is clasped.

Fig. 242.

If this precaution is neglected, the piece, from its weight, will act as a lever upon the tooth, and soon loosen it and cause it to drop out.

It often happens that pieces, made originally with clasps on both sides of the mouth, lose the benefit of one clasp from the loss of the tooth; and yet the patients retain them in place, and often use them as well as before. The piece is then, in part, retained by the fit of the plate to the gum; in other words, by atmospheric pressure. From which cases we may learn that if only one clasp can be attached to a plate with from four to six teeth, it will be advisable to cover rather more of the surface of the mouth. In this combination, the clasp gives steadiness, and the close fit of the plate to the gum gives adhesion.

BICUSPIDS WITH ONE CLASP.

The manner of constructing a substitute for two upper bicuspids on the same side of the mouth is exhibited in Fig. 243; but when the adjoining first molar does not offer a suitable support for the piece, the plate may be extended backward, and secured by clasp to the second; if this also is diseased, or has been removed, the plate must be carried across to the opposite side of the mouth, and secured to such teeth as may there offer the best means of attachment. But in this, as in similar cases, the plate should be thick, and adapted with the most perfect accuracy to the parts against which it is to rest. If the clasp or clasps are of the proper width, and well adapted, the teeth will be held firmly in place, and can be worn without inconvenience.

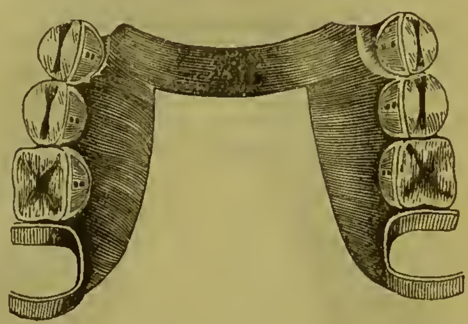
Fig. 243.

But a small plate, as shown in Fig. 243, does not afford so firm a basis for mastication, where there are antagonizing lower bicuspids, as a larger plate passing across the arch. Such a plate should be curved on the front edge, as seen in Fig. 244, but must be twice or three times as wide as the connecting band there shown. Either two clasps may be used, or one, and that on whichever side the most suitable tooth is situated.

BICUSPIDS AND FIRST MOLARS WITH CLASPS.

The usual plan of constructing a plate for the substitution of these teeth is to cover the parts of the alveolar ridge to be supplied with artificial teeth, extending the plate across and immediately behind the front teeth, and confining the posterior extremities with clasps applied to the second molars. Fig. 251 gives some idea of the shape of such a plate, except that there should be no outside front band, nor should the front of the plate run up with festooned edge against the teeth. It is thought, by some, that greater stability may be given to the piece by using two separate plates and connecting them together by means of a strip of thick plate passing across the palatine arch, in the manner shown in Fig. 244. This method of connecting two pieces was described to the author in 1844, by the late Dr. L. Roper. It will also be found valuable for giving stability to a narrow atmospheric-pressure plate (Fig. 249) for an entire upper set of teeth.

Fig. 244.

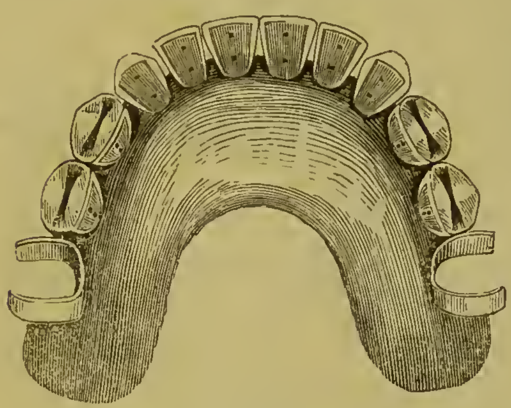


Another method, stronger than this, is to make two connecting-bands—one in front, the other behind. The best way to make such a plate is to swage in one piece, and then cut out the centre. The only reason why such pieces are more steady than the solid plate is because there is no bearing upon the hard central portion of the palate to cause a rocking or tilting motion. The same result may be reached by filling up the central part of the model, so as to take off the bearing of the plate. The latter makes a stronger plate, and if the space is made a *vacuum* cavity, the plate may adhere at once, without the necessity of clasps. But the advantage of cutting out the plate is the exposure of a larger surface of the mucous membrane—a very desirable point with some patients.

INCISORS, CUSPIDS AND BICUSPIDS WITH CLASPS.

When the crowns of the first molars of the upper jaw are long, well developed and in a healthy condition, the loss of the ten anterior teeth may be replaced with an artificial substitute, such as is represented in Fig. 245, that will subserve the purposes of correct enunciation, as well as the natural organs, and upon which mastication may be conveniently performed. The teeth should be attached to a thick, strong plate, and secured to the first molars by broad clasps. They must, of course, be accurately antagonized; for upon this will their utility, in a great measure, depend. The plate, too, should extend on the inner side of the arch back of the teeth to which it is clasped, and when the second and third molars are wanting, it may cover the entire alveolar ridge back of the first molars.

Fig. 245.



A plate of this size and shape is retained, not alone by the clasps, but also (provided it is well fitted to the gum) by atmospheric pressure. In fact, such a plate might even be worn without clasps, after it has once become perfectly adapted to the mouth; as we see often occurring in consequence of the loss by decay of the clasp-teeth.

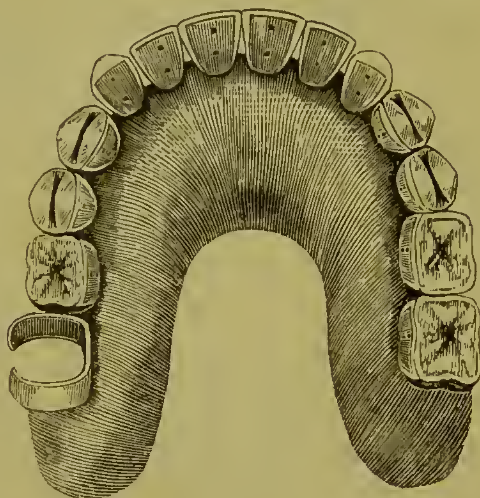
CLASP-PLATE WHERE ONLY ONE MOLAR REMAINS.

The dentist is sometimes called on to replace the loss of upper teeth, when there is only a single molar remaining. It would, unquestionably, be better, in cases of this sort, to remove the remaining tooth and apply a whole upper set on the atmospheric-pressure principle, but this he is not always permitted to do. One, two or four teeth remaining at the back part of the mouth do not necessarily prevent the use of an atmospheric plate, or require clasps. But a first molar, with no teeth behind

it, should be extracted, especially if, as is usually the case, there is any considerable absorption of its socket.

A clasp on a second (as in Fig. 246) or third molar can be of little service, except to give lateral stability to the piece. Its adhesion to the gum must be secured by accurate adaptation. This may be obtained, even where the plate is cut out, as in Fig. 246. Stiffness of plate is best obtained by having a thick plate; but it may be increased by the use of a band, as in Fig. 249.

FIG 246.



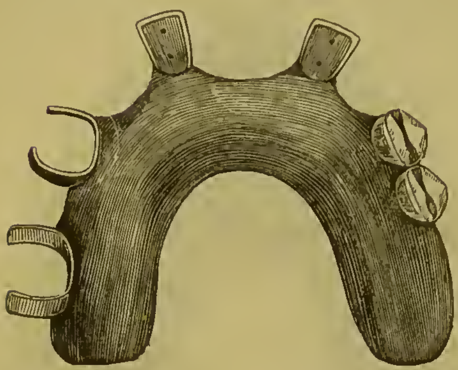
The propriety of allowing teeth to remain, in such cases, is often a difficult point to decide. A sound or well-filled healthy molar that has an antagonist ought not to be extracted merely because it would be easier to make a well-fitting plate. But where the teeth are diseased or loose, or the alveolus is much absorbed, they ought not to remain; and where they have no antagonist or are very much inclined, the propriety of their retention is doubtful. One point should, in all such cases, be submitted to the patient, namely; that one or two teeth interfere with the durability of a piece, as their ultimate loss may occasion such changes in the form of the mouth as to require a new piece.

LATERAL INCISORS AND LEFT BICUSPIDS WITH CLASPS.

It often happens that there are several spaces in the alveolar ridge which the dentist is called upon to fill, separated by one or more intervening natural teeth. The insertion of artificial teeth in cases of this description usually requires more judgment and skill than where there is only a single space. The impression is generally more difficult to take, and the plate will be much more troublesome to swage, unless all the teeth are cut down upon the model and die. The nice adaptation of the teeth to the shape of the gum and color of the teeth, so as to preserve a natural appearance, requires, also, the greatest

care. In selecting the teeth to be clasped, the rules before given must be observed. If choice of position is allowed, take second bicuspids or first molars in preference; never incisors, canines or third molars. In case of two clasps, let them be, if possible, on opposite sides of the mouth; but occasionally they may both have to be on the same side, as in Fig. 247, when the piece is of such size that one is not thought sufficient.

Fig. 247.



The plate should be kept clear of the remaining teeth, and if there are no antagonizing teeth beneath, the molars may be omitted, as in Fig. 247, to give as much lightness as possible; unless their omission causes a falling in of the cheek, in which case, two broad incisors might be substituted for molars. The different forms required for all varieties of such cases are almost infinite. The one given in Fig. 247 will serve merely to show the general plan of construction.

We have given the foregoing illustrations of partial clasp-sets of artificial teeth, as the use of clasps was formerly very general, and is even now not unfrequently demanded, either by the patient or by the nature of the case. Teeth are more firmly retained by them than by atmospheric pressure, and this, with many patients, outweighs all considerations of injury to the other teeth, &c. The method of insertion by atmospheric pressure will be noticed in the next chapter.

CHAPTER FIFTEENTH.

ARTIFICIAL TEETH RETAINED BY ATMOSPHERIC PRESSURE.

Of the two methods of retaining a dental appliance, already considered, the second, by clasps, is adapted only to partial cases; the first, by springs, is suited only to entire dentures. The principle of retention now to be considered, is applicable to either, and where practicable, is by far the most perfect way of securing the adhesion of a set of artificial teeth. We shall in the next section treat of a modification of this principle which comes, however, under the same physical law of "atmospheric pressure," that gives to the method its name.

Upon this subject Professor Austen remarks—"The surfaces of two pieces of highly polished ground-glass if pressed together will adhere firmly; so much so, sometimes, as to resist every attempt at separation. Surfaces less smooth and close-grained will also adhere with great tenacity, if their pores or irregularities are filled by wetting with water.

"If both surfaces are rigid and level, they may be made to slide upon each other, but will resist a force of five to fifteen pounds, for every square inch, if applied at right angles to the surface. But if one surface is soft and pliant, it becomes difficult to keep it in contact around the edges. Traction upon the centre (as in the case of a disc of wet leather upon a flat-stone) will draw in the edges and create a vacuum in the centre. Many suppose that in this vacuum space, lies the power that raises the stone: whereas, it lessens the power by reducing the area of stone, in contact with the leather. Still if the entire circumference is in contact, no air enters the cavity except what passes through the porous leather, and for a time the lifting power of the disc is sufficient to raise the stone. If traction be made upon the disc anywhere but in the centre the flexible edge will be raised, air gets between the surfaces and counteracts that pressure on the under side of the stone which was the lifting force.

"Hence, between two surfaces, adhering by simple contact, one of which is soft and pliant, adhesion is not so persistent as where both are rigid—because of the liability to separation around the edges, admitting air between the surfaces. Applying this to dental plates, we may understand their liability to become detached by a degree of motion which separates them from the gum at any one point around the edge. We learn also, that so long as absolute contact is maintained, we have the most perfect exclusion of air practicable; hence, no force of adhesion in a limited vacuum cavity, (the perfect exhaustion of which is impossible,) is comparable to the adhesion of the entire surface of the plate—provided this is made as perfect as possible by accurate workmanship, and is not weakened by the admission of air around the edges.

"It is well known that the tissues and fluids of the body are, in common with all matter at or near the level of the sea, subject to a pressure which is only felt when its equilibrium is disturbed. This pressure measures the weight of the superincumbent atmosphere, and amounts to fifteen pounds upon every square inch of the body, pressing alike in every direction, upward, downward and laterally. If we exhaust the air from the barrel of a key, and apply the lip it will be drawn in, and held with a force sufficient to support the weight of the key for some time.

"This simple experiment is instructive, if we will only study its teachings. The mucous and submucous tissues are pressed into the key, because the fluids pervading these parts, being under pressure in every other direction tend toward the point from which the pressure is wholly or partially removed. The extent to which the lip is drawn into the key will depend upon two conditions. *First*, the softness and mobility of the tissue; *secondly*, the shape of the edge of the orifice. If, in addition to these two points we inquire, *thirdly*, why the key, after a time, drops off, we shall from this simple illustration have fully explained the rationale of the vacuum cavity, as applied for the retention of a piece of dental mechanism.

"*First:* the extent to which, or rapidity with which a partial vacuum becomes filled up by any yielding tissue with which it is brought in contact, depends upon the mobility of its structure.

(We say, partial vacuum, because the process of mechanical exhaustion can never produce a perfect vacuum. Theoretically, there is no such thing as an absolute vacuum. That of contact, is the most complete, but the most compact substances can be proved to be porous: the Torricellian vacuum, or that from condensed steam, contain, in the one case, vapor of water, in the other, vapor of mercury.) If the water which gives softness to the mucous tissues were perfectly free to move, the cavity would be instantly filled, however deep. Parts as mobile as the tongue and lips, yield readily to this fluid pressure; but the super-osseous mucous membrane, being more or less tied down to the bone, fills the cavity more slowly, and, if too deep, will not fill it at all, except by increase of substance (hypertrophy).

"But again, reverting to the experiment of the key, if violent suction is made, a purple spot is left upon the lip, which is thus caused—the mucous tissues being prevented by their structure from filling the vacuum, the fluids still feel the *vis a tergo* of atmospheric pressure. The most abundant of these fluids, the blood, is thus impelled with a force which the thin capillary walls cannot resist, and *extravasation* of blood is the result. This is also seen in the application of "dry cups." Hence, we see, that where the cavity is so deep, or the tissue so rigid as not to fill it, if the degree of exhaustion is such, as still to draw upon the surface, the tissues are in danger of being ruptured. Such a source of irritation will, in many persons, develop a morbid action, which should forbid the action of this method of attaching plates.

"*Secondly:* the shape of the edge modifies the rapidity with which the cavity fills. For instance, under a cupping-glass, if the edge is rounded, the skin slides over it, and is drawn, with the sub-cutaneous tissue, from the adjoining parts into the glass; but if the edge is ground so as to present a sharp right-angle on the inside, this edge embeds itself in the surface, and prevents so much of the adjacent skin from being drawn in. It rises to a less height in the cup, and the force of the vacuum is then spent upon the capillary vessels, which are ruptured. Hence, we learn, that sharp-edged cavities fill less rapidly, but act with more power upon the tissues, and are consequently more apt to excite morbid action.

"*Thirdly:* as to the cause of the final dropping off of the key. All water, and all the moist tissues of the body, contain atmospheric air, which they yield up under a vacuum. Hence, a mucous membrane, although, at first drawn strongly into a cavity, will make the vacuum less complete, by giving out the air contained in its tissue, and in the blood constantly circulating through it. The adhesion of a vacuum, therefore, over mucous membranes, requires renewal by occasional suction, since the blood, containing air, is constantly circulating through the surface, and supplies air to the cavity.

"In this connection, I would direct attention to the property which mucous membranes have of *absorbing* air. This is seen in the lining of the bronchial cells constantly, and in the power of the mucous membrane of the intestines to absorb the gases there generated. This property acts an important part, when there is no power of the vacuum to counteract it, in absorbing small quantities of air, unavoidably caught between the plate and the mouth. It explains, in part, the well known fact, that plates adhering by simple contact, become tighter after being worn awhile; while, in the last paragraph, the reason is given why plates adhering by means of the vacuum cavity are firmest at first.

"The practical inference from the foregoing remarks, is, that the vacuum cavity acts well at first, and may be useful for the temporary purpose of retaining a plate, until the changes of which the mouth is capable, adapt it more perfectly to the plate; but for permanent adhesion, the only reliable application of the atmospheric-pressure principle, is, the 'vacuum of contact,' to be found only in well fitting plates.

"In conclusion, we remark, that a vacuum cavity acting as such, gradually draws the gum into it, and finally fills it by a more or less permanent enlargement; (or if the shape of the cavity is such that it is impossible to fill it, the irritation is apt to excite morbid action,) and that, when thus filled, the plate is then retained, solely, by the vacuum of contact. But when a cavity, intended to hold up a plate, leaves no prominence or mark in the mouth, it unmistakably proves that it is exerting no force; it then diminishes the force of adhesion by the presence of air, and has no compensating advantage, except in

removing pressure from a hard central ridge, and thus lessening the tendency of the plate to rock."

The engraving, Fig. 248, represents the appearance of a dental substitute for the upper teeth. The difference between the plate applied upon this principle and one with spiral springs, is, that the former is rather wider than the latter, covering more of the roof, so as to give a larger surface for the pressure of the atmosphere. It covers the whole of the outer surface of the alveolar ridge, and a considerable portion of the roof of the mouth; but it should not go as far back or run so high up as some dentists are in the habit of extending it. If allowed to cover those parts of the membrane, which cover the insertion of the cheek muscles, on the outside of the ridge or the palate muscles at the back of the mouth, the gums will be chafed or ulcerated, the patient nauseated, and the piece rendered unstable by the action of the muscles. Unless it be made to touch every portion of the surface which it covers, it will be constantly liable to drop.

Fig. 248.

It is not always necessary to employ a very wide plate to secure a sufficient amount of suction for its retention. A comparatively narrow one may often be made to adhere with very great tenacity to the gums. But a plate of this kind is more liable to be bent, and lose its perfect adaptation to the parts than a wide one, unless made of thicker gold. Its liability to be injured, however, in this way, may be measurably prevented by extending a piece closely fitting the palatine arch, across from one side to the other, (Fig 249,) in manner recommended by Dr. Roper for certain partial cases. (Fig. 244.) In this way, great stability may be given to a plate

Fig. 249.

for an upper circle of teeth, without encumbering the mouth with a wide plate. It might also be used with great advantage in cases where it is necessary to employ spiral springs.

The successful application of artificial teeth, upon this principle, depends upon having the plate accurately adapted to the parts upon which it is to rest. But however accurately a plate may be made to fit the model or metallic die, it is sometimes warped in soldering the teeth to it, thus destroying its adaptation and causing it to rock when placed in the mouth. When this happens, it cannot be made to adhere to the gums, and consequently cannot be worn with comfort. For the restoration of the plate, a variety of means have been proposed. The one which the writer has found most successful, consists in binding it to the plaster model with a fine iron wire in such a way that it shall be made to touch every part it covers; then gradually heating the piece to a cherry red heat with the blow-pipe flame, first protecting the teeth with a thin layer of soldering-mortar.* Others cut out from the lead counter a space to admit the teeth, and re-swage the plate with the teeth attached. But often the fault is irremediable, except by removing the teeth, and re-swaging; and then the solder remaining on the plate makes it more apt to warp than before.

Undoubtedly prevention is, in this case, better than cure; especially, as a proper attention to certain points in the construction of a piece of dental mechanism, will with certainty prevent the accident. The points which have special reference to the warping of plates are, briefly—a pure plate and careful annealing; slow cooling after the final annealing; proper investment in the soldering mortar, and slow heating and cooling; such adjustment of the backings that the plate shall not be incurably warped, by the contraction of a solid ridge of solder across the front backings; proper jointing of gum and block teeth.

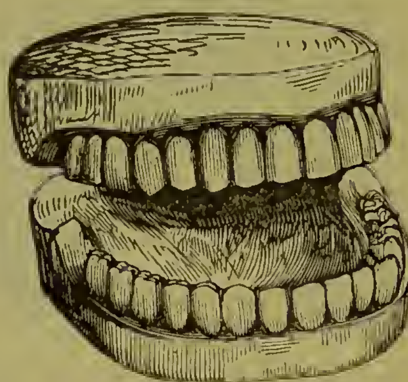
But with all the care and precaution that can be used, it is not possible, in every case, to secure absolute accuracy of adaptation, as the dies between which the plates are swaged are necessarily more or less bruised in the operation. The yielding gum permits a slight deviation from this course; but many cases

* The name suggested by Professor Austen for all mixtures of plaster with other substances to enable it to resist the contracting effect of heat.

will require two or three dies of zinc, and, of softer metals, at least five or ten. The inaccuracy caused by metallic shrinkage has elsewhere been spoken of, and the proper remedy directed.

In the application of a double set, on this principle, the lower plate should be as wide and long as the alveolar ridge of the inferior maxilla will admit of its being made. Fig. 250 represents a dental substitute attached to a plaster antagonizing model. The extremities of the lower plate, as may be perceived, extend up about half an inch on the coronoid processes. The lower alveolar ridge, in the case for which these plates were constructed, was almost wholly wanting, and each side was covered with loose folds of mucous membrane, so irritable as to prevent the patient from wearing artificial teeth applied with springs. She has worn the set here represented for many years without having experienced the slightest inconvenience.

FIG. 250.



When the teeth are put into the mouth, the patient may be directed to exhaust the air from between the plate (or plates, when a double set is applied) and gums; if properly fitted, this will at once cause them to adhere, though not at first, with as much tenacity as after having been worn a few days or weeks, for the reasons given by Prof. Austen. But lower plates and upper ones without a vacuum cavity, do not necessarily require this suction effort on the part of the patient: it is sufficient, simply, to put them in place with slight pressure to force out the air.

In replacing the loss of the bicuspids and molars of the upper jaw with artificial substitutes, mounted upon an atmospheric or suction plate, some dentists seek to give increased stability to the piece by constructing the plate in such a manner that a narrow band shall pass in front of the alveolar border, as represented in Fig. 251. But unless this is fitted with great accuracy it will irritate the gums: it is also very apt to be seen in talking or laughing, we, therefore, decidedly prefer to give the required strength by increasing the thickness of the plate. Where the second or third molars remain on either or both sides, an atmospheric-pressure plate

will answer better than any other kind. This principle may be combined with the use of clasps, as in Fig. 246, or the plate

Fig. 251.

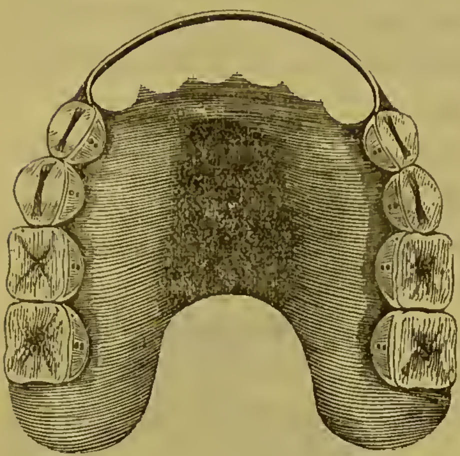
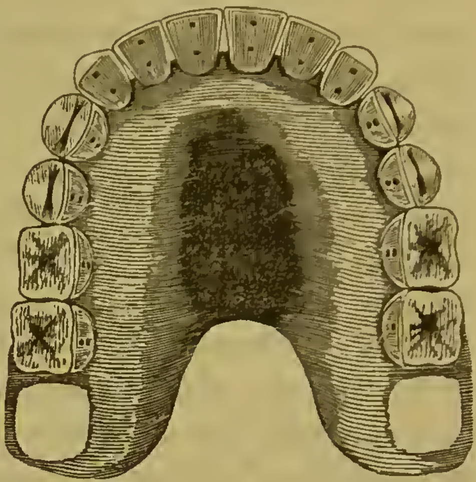


Fig. 252.



may be cut out, so as to pass over the remaining teeth as recommended by Dr. Hayes, (Fig. 252,) or it may be carried along the inside only of the ridge.

In the application of one or two teeth by atmospheric pressure, it is necessary to employ a wide plate, in order to present as much surface for the atmosphere to act upon as possible. A substitute for the two central incisors mounted upon a single plate, to be applied upon this principle, is represented in Fig. 253. Professor Austen's method is "to prevent lateral motion by a stay or narrow semi-clasp on each side, to cut the plate as much as possible from around the intervening teeth, and to depend for adhesion upon accurately fitting the plate to such part and extent of the mouth as the varying circumstances of each case may require."

Fig. 253.

THE VACUUM CAVITY.

A metallic base for artificial teeth may be made to adhere to the gums in many cases with greater tenacity when first inserted, by having it constructed with a cavity opening upon them, than by simple adaptation, however accurately the plate may be fitted.

Still, in the majority of cases, it will adhere with sufficient tenacity for all useful and practical purposes; and if a plate of this kind can be so applied as to secure *perfectly* the *atmospheric principle*, no permanent advantage whatever is derived from a chamber in the plate, opening upon the gums. Professor Austen's explanation of the theory of adhesion of atmospheric-pressure plates, fully sustains this opinion, which our practical experience has led us to adopt. Whilst, therefore, with him, we condemn the indiscriminate use of "cavity plates" as practiced of late years, and almost regard its introduction as a misfortune, yet we have found them very useful in certain cases.

The reason of the failure of a simple atmospheric-pressure plate to fit firmly when first inserted is (as explained by Dr. Dwinelle), that when the plate is applied and an effort made to exhaust the air from between it and the gums, the latter, along the line and behind the edge of the plate, are drawn down so as to meet it, thus resisting every effort made from without to withdraw the air from the central part of the plate; so that the pressure of the atmosphere is exerted upon only a small breadth of surface, along the edge of it, where the suction is constantly liable to be disturbed in biting upon the teeth.

With the view of obviating this difficulty, the idea of constructing a plate with a cavity, suggested itself to the writer as early as 1835, and was mentioned at the time to several of his professional brethren. The construction of the chamber which he then devised was found objectionable, and he abandoned its use; and it was not until the early part of 1848, when he had an opportunity of seeing a cavity plate contrived by Dr. J. A. Cleaveland, that he was again induced to construct a base of this kind. Dr. C. had first made cavity plates two or three years previously to this time. Dr. W. H. Dwinelle made a cavity plate with an external opening and valve for exhausting the air, in the winter of 1845; and in the summer of 1847, or '48, Dr. Jahial Parmly exhibited to the author a plate with a simple cavity struck into it by swaging. Some months after, he heard, for the first time, of a cavity plate, contrived and patented by Mr. Gilbert, of New Haven. The cavity in most of the plates now employed, is formed nearly in the centre, either far back on the plate or immediately behind the alveolar ridge; but Dr. J. F. B.

Flagg has recently added two lateral cavities, which are said to prevent the plate from rocking, and to give it increased stability. With this brief history of cavity plates, we shall proceed to give a short description of the manner of constructing them; beginning first with the cavity-plate and valve of Dr. Dwinelle.

To the plaster model, a piece of wax about an eighth of an inch thick in the centre, and five-eighths in diameter, but gradually diminishing toward its border, is placed just behind the alveolar ridge. With the model thus prepared, a metallic die and counter-die are obtained. A plate is then struck up in the usual way; then with a very small drill a hole is made through the centre of the raised part of the plate. This is next reamed out to a cone shape, the base terminating outward, and not exceeding half a line in diameter. A piece of gold wire is then fitted to the conical hole in the plate, leaving an extension to pass up through the plate in the form of a stem. It is next placed in the lathe and ground down with powdered Scotch-stone and oil, until it fits the cone-shaped hole in the plate so perfectly as to render it completely air-tight; the base is then filed down to a level with the plate. A very simple spring is made of a single strip of gold, with one end attached to the plate, like a tongue to an accordeon, making a hole or slit in the end of it for the reception of the stem of the valve. Dr. Dwinelle also recommends that a piece of plate be soldered on the part of the chamber pierced by the hole to increase its thickness.

Fig. 254.

Fig. 255.

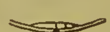


Fig. 254 represents an enlarged view of the valve and socket *a a* without the spring; also showing the raised part of the plate *b b*, in which the conical valve *a a* is fitted. In Fig. 255, the valve spring and plate combined, are represented. In exhausting the air from the cavity, and between the plate and gums, the valve is depressed, and the air drawn through the small opening, the closure of the valve preventing its return.*

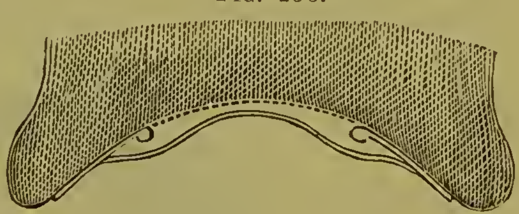
The next description of cavity plate which we propose to notice is the one contrived by Dr. Cleaveland, and the following is the mode of its construction:

A metallic die and counter-die having been obtained, a plate

* Dr. Dwinelle on Cavity Plates, in No. 2, vol. x, Amer. Jour. of Dent. Sci.

is struck up covering the entire alveolar border and extending back as far as the termination of the hard palate. This done, it is placed in the mouth, and if found to be accurately adapted to the parts against which it is placed, it is then removed, and a piece of half round gold wire about the size of a common knitting needle, soldered to the lingual side of the plate, behind the alveolar ridge, describing a circle about three quarters of an inch in diameter. The part within the circle is next cut out with punch forceps or saw, and the plate then placed on the model, and a piece of softened bees-wax, about a tenth or twelfth part of an inch in thickness, having a circumference one-fourth greater than the hole in the plate, is placed over the opening, extending a short distance beyond the wire on every side. The wax at the outside is brought to a thin edge, and is also much thinner in the centre than where it covers the wire surrounding the opening in the plate. A sand-mould of the model, with plate and wax upon it, is next taken, and from this a metallic die and counter-die are obtained. A thin plate of gold, large enough to cover the wax on the first plate, is now swaged between these dies, its edge chamfered off and then soldered to its place on the plate. It may be secured during soldering either by iron-wire clamps or by gold rivets. A sectional view of the cavity is represented in Fig. 256. The teeth are adjusted and soldered in the same manner as in the case of other plates.

FIG. 256.



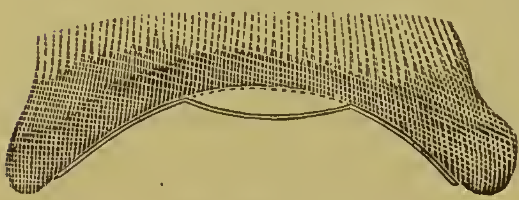
The Cleaveland cavity causes the plate to adhere with great tenacity, and as from its shape it is impossible for the mucous membrane to fill it, the traction of this cavity is constant. A serious objection to its use is the great irritation it excites in the mucous membrane in the majority of cases.

The simple cavity plate employed by Dr. Jahial Parmly, of New York, and patented by Mr. Gilbert, of New Haven, may be formed with as much ease as the ordinary plate, and in most cases, will answer as well as any other. The process of forming a plate of this sort is, first, to place a piece of softened wax on the centre of the model. In the centre it should be about the tenth part of

an inch in thickness, gradually diminishing to the circumference, and about three-fourths of an inch in diameter. With the model thus prepared, a metallic die and counter-die are made, plate swaged, &c., in the manner already described.

Fig. 257 represents a sectional view of a plate of this description. If it is desired to have lateral chambers in the plate, three pieces of wax are placed on the plaster model instead of one. One may be placed in the centre, as already described, and one on the slope of the alveolar ridge on each side.

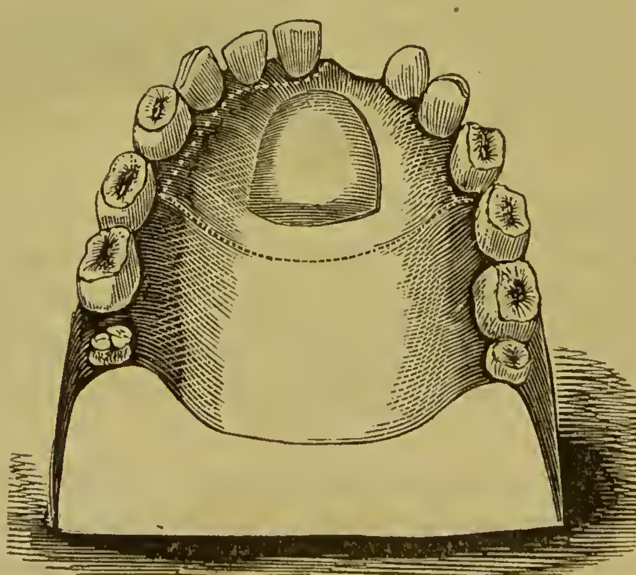
Fig. 257.



When it is desirable to make a cavity with sharply defined border, the projection on the model should have a decided edge instead of a gradual slope. A second plate a little larger than the projection, should be swaged with the base-plate. From the base-plate the projection is to be cut out, and the smaller plate soldered over the opening. For hard mouths the thickness of the main plate will give sufficient depth of cavity; in this case no projection is to be placed on the model.

The remarks which we have thus far made upon cavity plates,

Fig. 258.

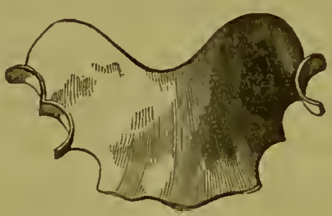


apply to entire dentures for the upper jaw. But they are applicable to partial cases in the upper jaw. In no case is a cavity to be placed in a lower jaw plate. With a cavity plate, the loss of a single tooth, or any number of teeth, may be replaced

without the aid of clasps, or with only the use of stays or half-clasps to steady the piece. The injurious effects liable to result from the use of clasps which have already been noticed, are obviated by applying the atmospheric-pressure principle to partial cases. So successful has the use of cavity plates been in the hands of the author, that he rarely finds it necessary to employ clasps.

The size of the plate which he employs for a single incisor, or for two or three front teeth, is indicated by the dotted line on the plaster model, as represented in Fig. 258. When more than two or three teeth are required, a larger plate may be employed. The size of the cavity is also represented; but the artist has made it too large, carrying it too close to the front edge of the plate. In some cases it may be better to run the plate back on the sides with lateral cavities and stays, cutting it out in the centre. In Fig. 259, such a plate is seen with stays attached, but the lateral cavities are not marked.

Fig. 259.



Prof. Austen dispenses with the cavity not only in full permanent plates, but also in most partial cases. We are satisfied that the vacuum cavity is too often used as a substitute for accurate workmanship. When a piece of dental mechanism, made for a mouth in which absorption is complete, is firm when first introduced (by aid of a cavity) and afterward loosens, it gives strong evidence of such substitution. The cavity becomes filled with the enlarged membrane, no longer acts as a vacuum, and the imperfect adaptation of the plate is revealed. Whereas, the plate without cavity, perhaps not very firm at first, daily improves, provided it is accurately adapted and the mouth undergoes no change. Again, and lastly, when a cavity is used in a plate that needs none, except perhaps for the first few weeks, the adaptation of the plate alone retains the piece; the cavity ceases to act as a vacuum cavity, and the proof of this is seen in the fact that it leaves no mark on the membrane. It is then useless except to relieve pressure over the central hard parts of the mouth. Hence the propriety of Prof. Austen's rule, "Use the vacuum cavity in a minority of cases, and never make it more than half a line deep for soft surfaces, or one fourth of a line for hard membranes."

CHAPTER SIXTEENTH.

PORCELAIN BLOCK TEETH.

The perfection to which the manufacture of block teeth has now arrived renders this description of substitute for the loss of the natural organs superior, in many respects, to single gum-teeth. The objections that formerly existed to their use have, one after another, gradually disappeared before the march of improvement, which has been as actively and as successfully at work in this as in any other department of dental art. But more time and more close and persevering application, are necessary to obtain a thorough knowledge of this than almost any other branch of practical dentistry; also, more constant practice is required to keep the hand trained to the requisite skill. The preparation of the various materials which enter into the composition of block teeth requires some knowledge of chemistry; and to incorporate these materials together after they have been prepared, and mould them into a dental substitute, demand the nicest and most skillful manipulation. The slightest error in the preparation or mixing of the materials will often give a result entirely different from the one aimed at; and teeth made by different persons, or at different times by the same person, from the same recipe, may differ widely in appearance, depending on the manner in which they have been mixed, worked or fired.

In the description which we propose to give of the manner of making and mounting block teeth, we shall begin by enumerating the materials that enter into their composition.

SILICIOUS AND ALUMINOUS MATERIALS.

Porcelain teeth are composed of two portions; one is called the BODY, and the other the ENAMEL. The body is composed principally of *feld-spar*, *silex* and *kaolin;* and the enamel of *feld-spar*, with a small trace of *silex* and *coloring* material. Va-

rious metallic oxides or metals, reduced to a state of minute division, are the materials used for the purpose of giving the necessary shades of color.

Feld-spar.—This mineral, commonly called, by porcelain-workers, *spar*, occurs in a crystalized shape, in the form of oblique, rhomboidal prisms, and is of a white, gray, red, brown, green, yellow or bluish color. But the only kind suited for use in the manufacture of porcelain teeth is the pure white. It consists, according to Rosè, of:

Silica, ...	68.50
Alumina, ...	17.50
Potash, ...	12
Lime, ...	1.25
Oxide of Iron, . . .	.75
	100.

It is found near Boston, at New Bedford, Oakham and West Springfield, Massachusetts; at Ticonderoga, New York; near Philadelphia, Pa.; near Wilmington, Del.; near Baltimore, Md.; and in various other places in the United States. But the Wilmington, Philadelphia and Boston spars are regarded as the best varieties for porcelain block teeth.

Previously to use, it is put in a furnace and heated nearly to a white heat, then thrown into cold water. It is then broken into small pieces, freed from impurities, and ground in a mortar or mill to fine powder, or until it will pass through a sieve of No. 9 bolting cloth. Feld-spar is easily fused, and, when thoroughly mixed with silex and kaolin, its fusion imparts to the mass a semi-translucent appearance.

Silex.—Flint, quartz and white sand are the purest varieties of silex. For porcelain teeth, the crystaline form is the best; this is found in great abundance in various parts of the United States. It is prepared for use by heating it to a white heat, then plunging it in cold water, and afterwards reducing it to a fine powder in a quartz or wedgewood mortar.

Kaolin.—This is the Chinese name for *porcelain clay*. Beds of kaolin are formed in nature by the slow decomposition of the feld-spar of granite hills, which is pulverized by the action of the elements and washed down into the plains below. It con-

sists of nearly equal proportions of alumina and silica, which is the result of the decomposition of mineral feld-spar, and is of a yellowish or reddish-white color when pure. It is found at Montauk, Vt.; at Washington, Ct.; at Fairmount, near Philadelphia; near Wilmington, Del.; in Missouri, and in South Carolina.

It is prepared for use by washing in clean water. After the coarser particles have settled to the bottom of the vessel, the water in which the finer ones are suspended is poured off into a second vessel, where it is permitted to remain until the whole of the kaolin has settled to the bottom. The water is then poured off, and the kaolin dried in the sun.

There are other varieties of clay which have been found to answer quite as well as the porcelain. That which shrinks least is, of course, preferable. Two kinds are found near Baltimore, which shrink but very little in baking; one is of a grayish-white, and the other of a bluish-white, color. But less importance is attached to clay as a constituent of porcelain block teeth, at this time than formerly. Many dispense with the use of it almost altogether.

COLORING MATERIALS.

The materials used for coloring porcelain teeth are, as we have before stated, metals in a state of minute division, or metallic oxides mixed in certain proportions with the body and enamel. The following are the principal metals and oxides employed for purpose:

Metals and Oxides Used.	*Color Given.*
Gold and its Oxides, . .	Bright rose red.
Purple of Cassius, . . .	Rose-purple.
Oxide of Manganese, . .	Purple.
Oxide of Cobalt, . . .	Bright blue.
Platina Sponge or Filings, .	Grayish-blue.
Oxide of Titanium, . . .	Bright yellow.
Oxide of Silver, . . .	Lemon-yellow.
Oxide of Uranium, . . .	Greenish-yellow.

Of the above, gold and its oxides, platina sponge and oxide of titanium are the most important. With these, nearly every color and tint required may be obtained.

Metallic Gold.—This may be prepared for use by grinding gold, in filings or in leaf, with a small quantity of spar in a mortar, or on a slab, until reduced to a fine powder; or, if there be any doubt with regard to its purity, the following method may be adopted: Melt in a crucible with borax, twelve parts pure silver, four parts gold, and one part tin, stirring, while in a fused state, until the gold and silver are well mixed. It may then be poured into an ingot-mould, rolled very thin and cut into small pieces, or granulated by being poured into a vessel containing water in rapid motion. The whole mass is then collected, put into an evaporating-dish and nitric acid poured on. When this has become completely saturated with the silver, it is poared off in a vessel containing water, and fresh acid added, and the action continued until the whole of the silver is decomposed or dissolved, which may be known by the colorless appearance of the fumes. The pure gold remaining at the bottom of the dish is washed until completely free from acid. A simpler method of obtaining a fine powder consists in precipitating a solution of chloride of gold by means of proto-sulphate of iron; then washing the precipitate with dilute muriatic acid to remove all trace of iron, and afterward with water to remove the acid.

Oxide of Gold.—Dissolve gold-foil or pure gold in *aqua regia*, composed of one part nitric and two parts muriatic acid; dilute the solution with water and precipitate the gold with aqua ammonia, using the precaution not to add more than is required (if excess of ammonia is added, the precipitate will be re-dissolved and a fulminating compound formed); then pour off the acid and wash the precipitate with warm water until it is completely freed from salt of ammonia; after which it may be dried over a gentle fire.

Platina Sponge.—This is obtained by dissolving filings of the metal in a mixture of one part nitric and two parts muriatic acid, diluting the solution with an equal quantity of water, and precipitating the platina by muriate of ammonia; this is afterward separated, by filtration, in the form of a yellow powder, which, on being exposed to a red heat, will leave fine platinum in the form of a dark lead-colored spongy mass.

Purple of Cassius.—Recipe No. 1. This is a compound of gold and tin, and, according to Thénard, is thus made: Dissolve

the gold in a mixture of one part muriatic and two parts nitric acid, diluting the solution with water, filtering and diluting again with a very large quantity of water. Then dissolve the tin in *aqua regia*, composed of one part nitric acid, two parts water, and to every pint add one hundred and thirty grains of muriate of soda. The tin should be pure and added to the acid in small pieces, waiting for each one to be dissolved before putting in another. The operation should be conducted in a cool place, and very slowly. After it is finished, the solution is filtered, and about one hundred times its volume of water added. The solution of gold is now placed in a glass vessel, and that of the tin added to it, drop by drop, stirring constantly with a glass rod, until the liquid assumes the color of port-wine. When the precipitate has settled to the bottom of the vessel, the liquid is poured off, and the precipitate washed and dried.

Purple of Cassius.—Recipe No. 2. Dissolve silver coin in a mixture of one part nitric acid and three parts water, in a glass or porcelain vessel, applying a gentle heat. Filter the solution, and add a large quantity of water. Then add to the solution common salt, which instantly causes a dense white precipitate to fall; this is the chloride of silver, which must be thoroughly washed and dried. Next take a hessian crucible containing two and a half times as much carbonate of potash as there is chloride of silver; place in a strong fire, and add the chloride very gradually. When melted, remove the crucible, and reduce the silver to a convenient form. Now take of pure silver 432 grs., pure gold 48 grs., pure tin 36 grs. Put the gold and silver in a crucible, cover well with borax, and melt; then add the tin, and pour the melted mass immediately into cold water contained in a wooden or porcelain vessel, to granulate it. Collect the particles, melt and granulate again, repeating the operation two or three times, so as to mix the metals thoroughly together, covering the metal each time with borax, and raising the heat no higher than is necessary to melt it, as the proportion of tin would be lessened by oxidation.

Put the alloy in a porcelain evaporating-dish, and add nitric acid to decompose the silver, hastening the operation by a gentle heat. Should the acid cease to act before the silver is all dissolved,—which may be known by the fumes ceasing to rise,—it

must be poured off, and fresh acid added. When the silver is all dissolved, pour off the acid, leaving the precipitate behind. Put this, which is the purple of Cassius, in a deep glass vessel; fill it with water, and stir with a glass rod; let it stand until the sediment subsides; then pour off and add fresh water, repeating the washing until the water is free from all metallic taste. The purple of Cassius is now dried in an evaporating-dish, and must be kept dry for use. The nitric acid poured off contains the silver, and may be obtained in a metallic state in the manner above described for obtaining pure silver.

Oxide of Titanium.—This is found in nature—sometimes nearly pure, and sometimes combined with oxide of iron. The principal ores are: *sphene*, common and foliated; *rutile*, *iserine*, *menachanite;* and *octapedrite*, or *pyramidal* titanium ore. The purest varieties should be selected for use.

Oxide of Uranium.—The prepared article, as sold by chemists, contains about two parts of the metal, and three of the oxide, in the form of a yellow powder. It is generally used as found in nature.

Oxide of Manganese.—This occurs abundantly in nature, and is obtained from chemists in the form of a coarse black powder.

Oxide of Silver.—This is made by dissolving silver in nitric acid, and precipitating the silver by adding potash or soda to the solution. The liquid is then poured off, and the precipitate washed with water and dried.

Oxide of Cobalt.—The preparation of this oxide is attended with much trouble; but as the quantity used in the manufacture of teeth is so small, we do not deem it necessary to describe the process, especially as it can be obtained from most chemists. There is a preparation made from the oxide, superior to the oxide itself for coloring teeth. It is called, in popular language, the ashes of cobalt, and is made by wrapping the oxide in blue English laid paper, and burning it in a closed crucible. This gives a more desirable tint to the enamel of a tooth than the oxide alone.

COMPOSITION AND PREPARATION OF BODY.

We shall give the proportions, in Troy weight, of four recipes for BODY, either of which, if properly worked, will produce good teeth:

No. 1.

Delaware spar,	12 oz.
Silex,	2 " 5 dwts.
Kaolin,	$7\frac{1}{2}$ "
Titanium,	18 to 36 grs.

No. 2.

Delaware spar,	12 oz.
Silex,	3 " 8 dwts.
Kaolin,	8 "
Baltimore clay,	4 "
Titanium,	18 to 36 grs.

No. 3.

Delaware spar,	12 oz.
Silex,	3 "
Kaolin,	18 dwts.
Titanium,	18 to 36 grs.

No. 4.

Delaware spar,	16 oz.
Silex,	$3\frac{1}{2}$ "
Kaolin,	$\frac{1}{2}$ "
Titanium,	20 to 60 grs.

Put the titanium in a large mortar, and grind until it is reduced to an impalpable powder; then add the silex and grind from one to three hours, or until there shall be no perceptible grit; now add the kaolin, and grind from thirty minutes to an hour and a half; and, lastly, add the spar, little by little, and grind from forty to sixty minutes. All the ingredients should not be ground equally fine, as the translucency of the teeth is increased by having some coarser than the rest.

The materials may be ground dry or in water. If the latter method is adopted, a sufficient quantity of water should, from time to time, be added, to form a batter of the consistence of cream, and after the grinding is completed, it may be poured on a clean slab made of plaster of paris. As soon as the absorbing power of the slab reduces the mass to the consistence of stiff dough, it should be removed, and after having been beaten for twenty or thirty minutes on a marble slab, it must be put away in a covered jar for use. When the ingredients are ground dry, they may be mixed, a small quantity at a time, as they are needed for use. Many prefer having the materials ground in this way.

COMPOSITION AND PREPARATION OF ENAMEL.

Any of the following recipes will produce a good enamel, and among them will be found nearly every shade of color and tint required; others may be obtained, if desired, by changing the proportions of the coloring ingredients, but the author has not found it necessary to do so. The oxides should be reduced to an impalpable powder, and thoroughly incorporated with the enamel paste.

Grayish Blue Enamel,

No. 1.

*Boston spar,	2 oz.
Platina sponge,	¼ gr.
Oxide of gold,	½ gr.

No. 2.

Boston spar,	2 oz.
Platina sponge,	½ gr.
Oxide of gold,	½ gr.

No. 3.

Boston spar,	2 oz.
Platina sponge,	¾ gr.
Oxide of gold,	½ gr.

No. 4.

Spar,	2 oz.
Flux,	24 grs.
Platina sponge,	½ gr.

Yellow Enamel,

No. 1.

Boston spar,	2 oz.
Titanium,	10 grs.
Platina sponge,	½ gr.
Oxide of gold,	½ gr.

No. 2.

Boston spar,	2 oz.
Titanium,	14 grs.
Platina sponge,	½ gr.
Oxide of gold,	½ gr.

No. 3.

Boston spar,	2 oz.
Titanium,	16 grs.
Platina sponge,	½ gr.
Oxide of gold,	½ gr.

No. 4.

Spar,	2 oz.
Flux,	20 grs.
Titanium,	10 grs.

No 1 of the blue and No. 3 of the yellow, will produce an enamel that will suit a larger proportion of the cases than almost any other. The coloring ingredients should be first ground very fine with five or six dwts. of the spar, when the remainder of the

* Fuses at a somewhat lower heat than the varieties from other localities.

spar should be added a little at a time, and ground from thirty to forty minutes. The composition of the flux used in No. 4, is given on the next page.

The coloring ingredients for the following receipes are prepared by being ground very fine with spar.

Platina Coloring.

Boston spar,	1 oz.
Platina sponge,	1 dwt. 12 grs.

Titanium Coloring.

Boston spar,	1 oz.
Titanium,	7 dwts. 12 grs.

Grayish Blue Enamel.

No. 1.

Boston spar,	2 oz.
Platina coloring,	12 grs.
Titanium coloring,	2 "

No. 2.

Boston spar,	2 oz.
Platina coloring,	1 dwt.
Titanium coloring,	2½ grs.

No. 3.

Boston spar,	2 oz.
Platina coloring,	36 grs.
Titanium coloring,	3 grs.

Yellow Enamel.

No. 1.

Boston spar,	2 oz.
Titanium coloring,	1 dwt.
Platina coloring,	2 grs.

No. 2.

Boston spar,	2 oz.
Titanium coloring,	2 dwts.
Platina coloring,	2½ grs.

No. 3.

Boston spar,	2 oz.
Titanium coloring,	3 dwts.
Platina coloring,	3 grs.

The foregoing are ground separately until the coloring ingredients are thoroughly incorporated with the spar. By grinding the spar too fine, the life-like appearance and beauty of the enamel will be destroyed.

Grayish Blue Enamel.

No. 1.

Boston spar,	2 oz.
Platina coloring,	2 dwts.
Gold mixture,	4 grs.

Yellow Enamel.

No. 1.

Boston spar,	2 oz.
Titanium,	16 grs.
Platina coloring,	8 grs.
Gold mixture,	2 dwts. 10 grs.

The manner of preparing the coloring ingredients for the preceding receipe, is as follows:

Platina Coloring.—Platina sponge, 1 dwt., 12 grs.; Boston spar, 1 oz. $2\frac{1}{2}$ dwts., mix and grind very fine.

Gold Mixture.—Dissolve eight grains pure gold, in *aqua regia*, then stir in twelve and a half dwts. very finely ground spar. When nearly dry, form it into a ball, and fuse it on a slide in a furnace. After which, pulverize it coarsely and keep for use.

For the yellow enamel, first grind the titanium and platina sponge very fine, then add the gold mixture, which should also be ground fine; after which add the spar and grind until the coloring ingredients are thoroughly incorporated with it. Enamels made from any of the recipes here given may be used on any of the bodies.

Gum Enamel is made with spar and a *frit*, colored either with metallic gold in a state of minute division, its oxide, or purple of Cassius. Besides the coloring ingredients, gum enamel frit is composed of a *flux*, made especially for the purpose, and spar. We shall first describe the manner of making the flux.

Flux.—Silex, 4 oz.; glass of borax,* 1 oz.; sal tartar, 1 oz.; mix and grind to an inpalpable powder; then pack it in the bottom of a clean, light-colored crucible. Cover this with a slab of fire clay, previously fitted into the top, and lute with kaolin or clay. Now place the crucible in a strong anthracite fire, free from smoke, and let it remain until the mass is completely fused, which will require from an hour and a half to two hours and a half, according to the strength of the fire.

When cold, break the crucible, and remove every particle from the flux, which, if it has not become stained by coloring matter in the crucible, will be a transparent glass. If any portion has become discolored, this should be broken off, and the remainder pulverized, and kept dry for use. Flint glass is sometimes used for a flux.

Gum Frit, No. 1.—Metallic gold in a state of minute division, or its oxide, 16 grs.; flux, 175 grs.; spar, 700 grs.

* Glass of borax is made by putting the pure crystals in a clean light-colored crucible; then place the crucible in a charcoal fire, and let it remain until the borax assumes a transparent glassy appearance. Now pour it on a clean marble slab, and when cold, pulverize and keep in a well stopped bottle to prevent it from absorbing the moisture from the air.

Put the above in a mortar, and grind until it is reduced to an impalpable powder, which will require from five to eight hours constant labor, then pack it in a light colored crucible washed inside with a thin batter of very finely pulverixed silex, and outside with kaolin; now fit to the top of the crucible a piece of slab and lute it down with kaolin, place it near the fire, and when dry place it in a strong anthracite fire, free from smoke, where it must remain until it is fused, which will require from an hour and a half to two hours, then remove it and when cold, break the crucible and grind off the silex. This done, it may be broken and ground until it will pass through a No. 9 bolting cloth sieve.

Gum Frit, No. 2.—Purple of Cassius, 8 grs.; flux, 175 grs.; spar, 700 grs. Reduce the purple of Cassius, in a mortar, to an impalpable powder, then add the flux, little by little, grinding each time to a very fine powder. Now add the spar, a small quantity at a time, reducing each parcel to a very fine powder, and the whole to the utmost degree of fineness. To do this properly, will require from six to eight hours constant labor, and unless the mixing and levigation are properly conducted, the color will be unsatisfactory.

After having reduced the mass to the proper fineness, select the whitest sand crucible that can be obtained, fit a piece of muffle-slide to the top, as a cover. Now cover the internal surface of the crucible with a paste made from finely pulverized quartz, putting it on with the finger. This done, pack the frit into it in a dry state, then put the cover on and lute tight with kaolin. Put an external coating of quartz on the crucible, then bury it in a strong anthracite fire, and let it remain until the contents are perfectly fused. The time required for this, will vary according to the size of the crucible and the strength of the fire. When the frit is completely fused, the crucible may be removed from the fire; when cold, break it and remove every particle of foreign matter. Then pulverize until it will pass through a sieve of No. 9 bolting cloth.

Gum Enamel,

No. 1.		No. 2.	
Frit, No. 1,	3 dwts.	Frit, No. 2,	3 dwts.
Spar,	9 to 12 dwts.	Spar,	3 to 18 dwts.

The spar should be coarsely ground, in order to give the gum a granular appearance, and the quantity of frit may be increased or diminished until the right color is produced. It should, therefore, be tried on test pieces of body before being applied to a practical piece. Frit made at different times will produce different results. The gum-enamel, No. 2, is designed particularly for body No. 4, and tooth-enamel No. 4, but may be used on any of the other bodies, and with any of the other tooth-enamels.

Having enumerated the materials which enter into the composition of the body and enamels, and described the manner of preparing and mixing them for use, we shall proceed to notice the method of making and mounting the teeth. We shall begin by describing the manner of obtaining an antagonizing model for an upper set of teeth, and of making the matrix for moulding the body preparatory to carving the teeth.

ANTAGONIZING MODEL FOR AN UPPER SET OF BLOCK TEETH.

The method of obtaining an antagonizing model for block teeth is similar to the one described in a preceding chapter, and one made for this purpose will answer for any other kind of dental substitute. A rim of wax or of gutta-percha about half an inch thick, is placed upon the lower or convex surface of the plate. This is then adjusted in the mouth, and the patient requested to close his teeth in the wax with sufficient force to make an indentation in it, an eighth of an inch deep. The piece is now taken from the mouth, and the plate warmed so that the wax may be removed without changing its shape, and another rim, corresponding in width to the length required for the artificial teeth, fitted to the plate, which is again placed in the mouth, and the patient requested to close his teeth gently upon the wax. If all do not touch the lower edge of it at the same instant, it should be trimmed off until they do. The exterior surface of the wax should be also cut away until it describes the proper arch for the buccal and labial surfaces of the artificial teeth, and restores to the lips and cheeks their natural contour. This done, the patient is again requested to close his teeth upon the edge of the wax with just sufficient force to leave the imprint of each tooth.

The plate is now taken from the mouth, laid aside, and the wax first employed is placed upon a piece of pasteboard or paper, with the side in which the teeth were partially imbedded, upward. The exposed portion and indentations are slightly oiled, and plaster poured on it, filling the impressions made by the teeth, extending an inch and a half behind the rim, and the whole raised to a level of half an inch above the wax. As soon as the plaster has hardened, the edges should be trimmed off, and a crucial groove, or two or three conical depressions made in the lower surface behind the wax, which may now be softened and carefully removed, using the precaution not to break the ends of the teeth. This half-model of the articulator is placed upon a piece of paper with the teeth upward, and the rim of wax last used, still attached to the plate, is adjusted to the teeth in such a manner that the point of each shall enter the imprint made by the natural organs. The upper surface of the plate and model having been previously oiled, plaster is poured on for the formation of the other half-model of the articulator. When the plaster has sufficiently hardened, the two pieces are separated, and the plate and wax carefully removed, to be used for the formation of the matrix, in which to mould the body preparatory to carving.

MATRIX FOR MOULDING THE BODY PREPARATORY TO CARVING THE TEETH.

Having obtained an antagonizing model, the inside of the wax is cut away until it presents the appearance represented in Fig. 260. It should be left a little thicker than the artificial teeth will be, allowance having to be made for shrinkage in the baking, and also for the removal of a small portion in carving, especially at the part corresponding to the position of the incisors and cuspids. The plate and wax are now returned to the upper half of the model, and the exposed surfaces of both wax and model are oiled; then a thick batter of plaster of paris is poured on in the manner described for making the upper half of the antagonizing model: this forms the matrix. As soon as the plaster has hardened sufficiently, the edges are trimmed to the wax, the matrix separated, and the lower part of the antagoniz-

ing model applied. Vertical lines are now made across the wax, to indicate the width required for the artificial teeth. See Fig. 261. This done, the antagonizing half-model is removed, the

Fig. 260.

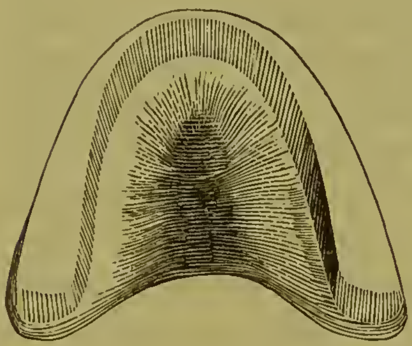
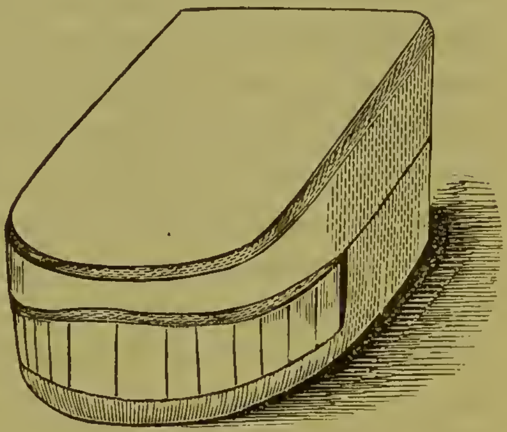


Fig. 261.



matrix applied, and the lines in the wax continued across the edge of it, to serve as a guide for marking the width of the teeth preparatory to carving. See Fig. 262. The two parts are again separated, and the plaster cut away from the surface of the matrix in contact with the wax, forming an open space between it and the edge of the wax, equal to about one-tenth or twelfth of the width of the wax. The matrix will now present the appearance, when the two parts are put together, represented in Fig. 262. The object of this space is to provide for the shrink-

Fig. 262.

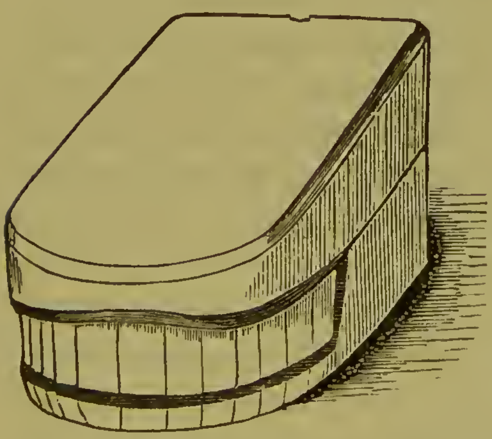
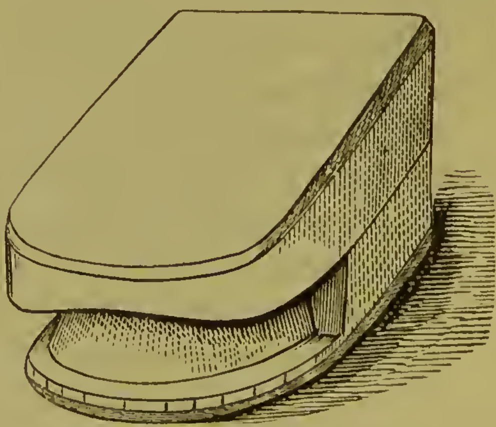


Fig. 263.



age in the length of the teeth, consequently its width should correspond with the amount of shrinkage of the body in baking. Body made from recipe No. 1, shrinks a little more than that

made from No. 2, and this a little more than body made from No. 3.

Having proceeded thus far, the wax may be removed, and a coat of varnish applied to each part of the matrix. The appearance of the two pieces when put together is shown in Fig. 263. The antagonizing model and matrix, as will be perceived from the foregoing description, consist of but three pieces, the upper half being common to both. By this simple contrivance, the artist will be able to adapt the coronal extremities of the artificial teeth to the opposing natural organs with accuracy, as he can at any moment remove the matrix-half, and apply the antagonizing half of the model to his work.

Some dentists are in the habit of first carving the teeth in wax, and making over it a matrix consisting of five pieces—one upper and one lower, and three for the sides and front. In this the teeth are roughly moulded. But as they afterward require trimming, and it is quite as easy, and much more expeditious to carve them from the porcelain paste in the first instance, a skillful workman can carve a double set, after having moulded the body in a matrix such as the one first described, in an hour and a half or two hours.

MOULDING AND CARVING.

A block for an entire set of teeth for the upper or lower jaw, shrinks so much in baking, as not only to destroy its adaptation to the plate, but also the proper relation of the artificial to the natural teeth. This difficulty may be measurably obviated by making three blocks, a central for the incisors and cuspids, and two lateral for the bicuspids and molars. Some are in the habit of making four, but with a good body, only three are required. The central should be made first.

If the composition for the body has been ground in a dry state, as much as may be needed at any one time should be put in a mortar, and a sufficient quantity of clean water poured on to form it into a thick batter, stirring it until thoroughly mixed. It should then be poured on a slab of plaster of paris, as before directed, for the absorption of the surplus water, and afterward beaten for a few minutes on a marble or porphyry slab. Thus

prepared, the matrix, after having been well oiled, is to be filled with the paste, patting it with the fingers for a minute or two, for the purpose of driving out the confined air.

As soon as the water has evaporated sufficiently, the paste protruding from the matrix may be trimmed off, the lower part of the mould loosened, but still kept in place, and the width of the incisors and cuspids marked with the point of a small carving knife upon the body, the notches across the edge (Fig. 263) of the lower part of the matrix serving as a guide for this part of the operation. The teeth, however, should be a little wider than the spaces thus indicated on the matrix, so that each cuspid will occupy one-third of the space indicated for the first bicuspid, this being about equal to the amount of shrinkage which will take place in the front or central block in baking.

After marking the width, the outline of the labial surfaces may be traced, and the carving commenced, copying nature as closely as possible. The teeth may be separated by drawing a thread, held in a small bow, between them. The antagonizing half of the mould may be applied from time to time, to enable the artist to determine the amount required to be trimmed from the palatine surface. In conducting this part of the work, a great deal of tact is required, as the slightest touch, or accident, will break the block—the body, in this state, being exceedingly tender and brittle. If it should, at any time, become too dry, it may be moistened by applying a little water with the point of the carving knife, or a small camel's-hair pencil. The portion back of the cuspid teeth is, of course, to be cut off.

Having completed the front block, it should be loosened from the plate, by gently tapping the part of the matrix to which it is attached, and then removed and placed upon coarsely pulverized silex, on a muffle-slide. This done, the matrix is to be refilled with paste, and the side blocks carved, making the first bicuspids to occupy about one-third of the spaces marked on the matrix for the cuspids. These side-blocks, when finished in like manner, are removed and placed with the central block on the slide.

The only instruments required for carving are two or three small knives, shaped something like the blade of a thumb lancet, but more pointed and smaller, with a handle made as light and delicate as possible.

CRUCING, OR BISCUITING.

As soon as the blocks have become thoroughly dry, the slide containing them must be put in the muffle of a furnace, previously raised to a bright red heat, sufficient to agglutinate the particles of the composition, but not to vitrify the body. This is called *crucing* or *biscuiting*, and is sometimes done in a charcoal fire, in a small open furnace, the blocks, in this case, being placed on some pulverized silex, in a crucible. But it is most readily effected in a muffle furnace.

If the carving has been roughly executed, the shape of the teeth may be to some slight extent altered, and any rough places removed after the blocks have been cooled. They can now be handled without incurring much risk of breaking.

Several methods of attaching blocks to a plate have been adopted, but the one which gives to the work the greatest permanence and stability, consists in soldering a band to platina pins inserted in the blocks behind the teeth. These pins are sometimes inserted before the blocks are cruced, but as the teeth are so exceedingly frail at this time, it is better to defer it until they have been subjected to this process. The manner of inserting them is very simple, and consists in drilling two small holes in the block behind each tooth, immersing the block suddenly in water, and inserting a pin flattened at the end, in each hole. The space around them should be filled with "body" mixed with water to about the consistence of thin cream. This may be applied with a small camel's-hair pencil, or with the point of the carving-knife. The pins should pass from half to two-thirds of the way through the block, and be about an eighth of an inch apart, one placed above the other. A set of blocks for the upper jaw with pins inserted are represented in Fig. 264.

Fig. 264.

ENAMELING.

The enamels, when applied, should be of the consistence of cream, and if the teeth are to have a uniform color, it will only be necessary to use two kinds, one for the teeth and one for the gum. But in the majority of cases three kinds are needed, a grayish blue for the lower part of the crown, yellowish near the gum, and rose red for the gum. The teeth should be well cleaned before the enamel is put on. The gum-color should be applied first, then the yellow, and lastly the grayish blue, and the best method of putting it on is with a small camel's-hair brush. It should be of uniform thickness and come down a little below the ends of the incisors and cuspids, so as to give them the translucency peculiar to the natural teeth. A thin coating may also be applied to the grinding surfaces of the molars and bicuspids. It is not required on the palatine surfaces. In applying the gum-color, care should be taken to prevent it from coming down on the teeth, and at the same time to have it form a well defined edge. The grayish blue should overlap the yellow, blending the two tints in such a manner as to render it impossible to tell where the one begins or the other terminates.

The enamels having been applied, the blocks are carefully placed on a bed of silex on the slide, and when perfectly dry, slid into the muffle of the furnace.

FIRING AND BAKING.

This may be done in a small muffle furnace, like the one represented in Fig. 265; some dentists have a furnace constructed differently, but the principle and general plan is the same. A clear, strong fire, made of the hardest anthracite coal, is required for baking the blocks. It is first kindled with charcoal, and, after this has become thoroughly ignited, the anthracite is added, a little at a time, until the furnace is full. As the muffle, at the high temperature required for fusing the blocks, and under the weight of the coal above, is liable to sink down in the centre, it should be supported by a rest underneath, made of fire-clay. The anthracite coal, after it has settled and become thoroughly

ignited, should be two or three inches deep on the top of the muffle, and the opening through which the fuel is introduced, closed.

Fig. 265.

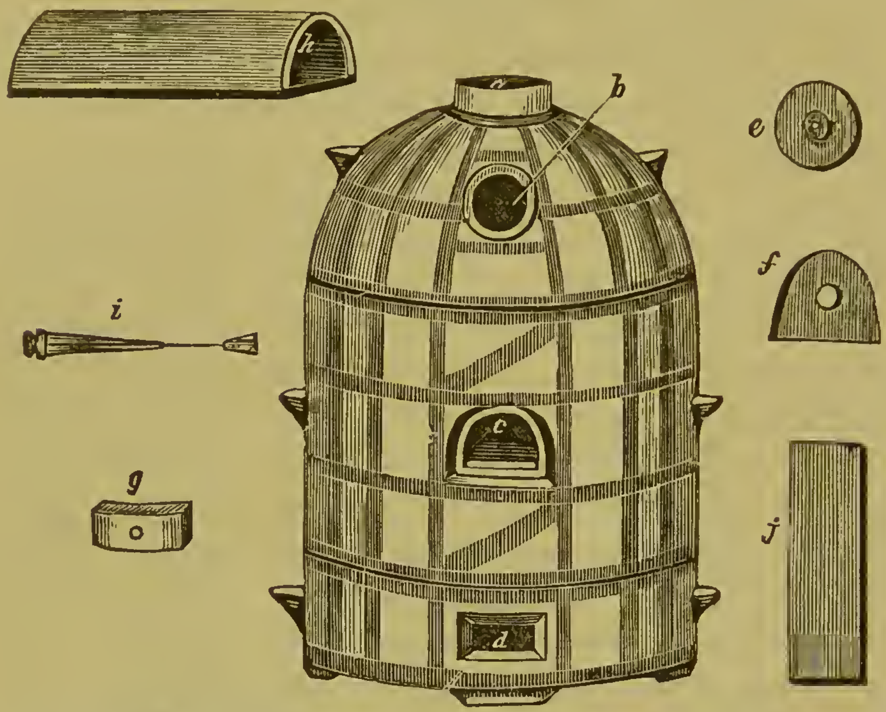


Fig. 265. A muffle furnace; *a* Collar for the smoke-pipe; *b* The opening through which the fuel is introduced; *c* The muffle opening; *d* The ash-pit door; *e* Stopper for the opening *b*: *f* Stopper for closing the opening to the muffle; *g* Stopper for the opening to the ash-pit; *h* muffle; *i* Stopper with platina wire and test; *j* Muffle-slide.

The furnace being thus heated, the slide (*j*) may be carefully introduced into the muffle (*h*) of the furnace, the opening closed, and the door (*f*) luted with fire-clay. Some dentists use a test piece, consisting of a small biscuited piece of the "body," with a little of the tooth and gum enamels on one side of it, fixed to the end of a platina wire, projecting from the inner extremity of a plug made of fire-clay (*i*), and fitting a hole in the centre of the door of the muffle. By withdrawing this, the progress of the baking can be ascertained: but the use of it is not necessary, to an experienced workman in constant practice. Most persons are in the habit of opening the door of the muffle, and partially withdrawing the slide, when it is thought the blocks have been baked sufficiently. When the enamel has become fused, and smoothly spread over the surfaces to which it was applied, the process has been carried far enough. The stopper of the fuel-opening may now be removed, the draft of air cut off from

the fire by closing the door to the ash-pit, and the furnace permitted to cool. When the combustion has ceased, and the temperature has become so much reduced as to permit the introduction of the hand into the muffle, the slide may be removed. If it is taken out before the furnace has cooled, the teeth will not be well annealed and will be very liable to crack under the blow-pipe.

FITTING AND ATTACHING THE BLOCKS TO THE PLATE.

The adaptation of the blocks to the base is, more or less, impaired by the shrinkage which takes place in baking, and as it is important that they should fit with the nicest accuracy, it frequently becomes necessary to grind them before attaching them to the plate. The blocks should also be fitted to each other so perfectly, by grinding, as to render the line of union scarcely perceptible, taking the precaution to insert the thin slip of paper elsewhere spoken of. Very small wheels are required in the latter part of the grinding process. Where the eye will not reach, accuracy of fit may be obtained by coating the plate with oil colored with lamp-black or vermillion: the spots on the base of the block which touch the plate will be colored. These are to be ground until the entire surface becomes spotted over, showing a very general contact with the plate.

Having accomplished this part of the operation, and antagonized the blocks properly with the opposing teeth, they are retained in place with a rim of wax, applied to their outer surface, where they join the plate; the plate behind the blocks is then oiled, and plaster poured on, filling the arch, and covering the coronal extremities of the teeth. When this has hardened, the wax on the outside may be removed: the blocks can now be taken from and applied to the base without disturbing their proper relationship. A strip of gold is then cut a little thinner than that used for the base-plate, about an eighth of an inch wide, and long enough to extend around the outside of the entire arch of the blocks. This should be slightly grooved, and accurately fitted to the plate along the outer edge of the blocks, with the grooved side toward them; the plate then marked with a sharp pointed steel instrument, on the outside of this rim. The

plaster and blocks must now be removed, and the strip of gold held in its place by wrapping the plate with fine iron wire. It is then soldered at three or four different points, and afterward all the way around to the plate.

This outside band is sometimes swaged up or soldered on before grinding the blocks; in which case the blocks must be fitted accurately to it. A dexterous workman can rapidly fit a straight band to an irregularly curved outline by the operation of "peening or paning." The strip is first "tacked" with solder to the front edge of the plate, and then with pliers bent to fit its curvature: any lateral curves required in the strip are given by striking it on a small anvil with the "pane" of a small hammer, the strip curving *from* the side on which the blow is struck: the pane being held at right angles to the strip. Others take an impression of the surfaces of blocks and plate which the band is to fit and swage the band. This is more troublesome, but gives an accurately fitting band.

The blocks should now be separated from the plaster, adjusted to the plate, and held in place partly by the rim just soldered to it, and partly by a rim of wax placed on the inside. The next thing to be done, is to apply a strip of gold from a quarter to three-eighths of an inch in width, and of the thickness of the plate, to the lingual surface of each block. A pattern for each of these linings is first made by applying sheet lead or tin to the block, which as it is pressed against it, is perforated by the platina pins. It is then trimmed to the proper size, and fitted accurately to the base. This is placed upon gold plate, and a piece of the same size and shape cut from it. The perforations in the pattern indicate the points at which the holes are to be punched through the linings; this done, it is applied and fitted tightly to the block, and held firmly in place by bending the platina pins. The pins are then filed off nearly up to the plate, and the block returned to its place. The lining should be made to fit the plate and the end of the lining of the adjoining block with the most perfect accuracy. If the inner curve of the block is considerable, or the pins close together or long, it will be found very difficult to fit the lining. For this reason some prefer to put small separate linings opposite each tooth. The finish is thought to be not quite so neat as the continuous

lining: but it is claimed that the risk of breaking the blocks in backing and soldering is much less.

All the linings having been applied and the blocks adjusted to the base, the teeth are held in place by a rim of wax on the inside, and the piece put in the soldering mortar, and otherwise prepared for the process of soldering according to the directions before given. Cautious heating up and very gradual cooling is especially necessary in the case of blocks, to prevent them from cracking. The process of finishing is the same as that for a set of single teeth mounted upon plate.

Fig. 266.

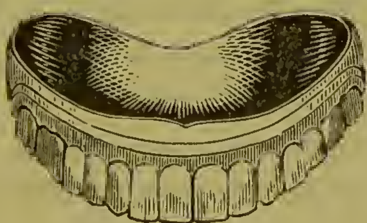
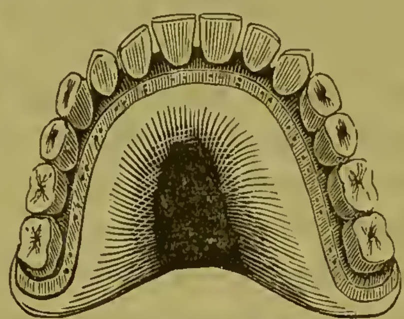


Fig. 267.*



Figs. 266 and 267 represent a front and palatine view of an upper set of block teeth mounted on a metallic base. The rim on the outside around the upper edge of the block is not always put on, but it adds to the strength and beauty of the piece, and also to its cleanliness, if closely fitted, as it always should be, to the blocks.

There are two other methods of attaching blocks to a plate. The first consists in making vertical holes through the blocks, one for each tooth, after they have been cruced. They are attached to the plate by a gold pin, which is either passed through each tooth and riveted on the upper side of the plate, or is first soldered to the plate, and then riveted on the grinding surfaces of the molars and bicuspids and the palatine surfaces of the incisors and cuspids. The second method consists in soldering pins to the plate which pass into holes made to run parallel to each other, half or two-thirds of the way through the teeth, one

* The originals of nearly all the illustrations in the foregoing chapter were made for the author by the late Dr. Mortimer D. French, of Toronto, Canada, formerly a student of his. For a number of the receipes the author is indebted to the courtesy of several professional friends, having large experience in this department of dental art.

to each tooth. The pins in this second method are held in two ways. First by a bushing of wood: in which case the holes in each block must be perfectly parallel and smoothly drilled, and the pins placed with greatest accuracy. (The method of placing the pins is the same as that given in page 622 for a pivot tooth pin.) But in the second way the holes may be larger, rough and irregular, and less accuracy is required in locating the pins. They are held in the block, and all spaces between block and plate filled, by some plastic material which has the property of hardening. This may be gutta percha, Hill's stopping, osteoplastic, sulphur, or, best of all, vulcanized rubber.

Of these different methods the first, by soldering, is undoubtedly the strongest. Next in point of strength is that by pins, if secured by vulcanite. The most objectionable method is that of the riveted pins. The pins bushed with wood make a very secure fastening, but require a nicety of workmanship which very few are equal to.

In making blocks for either a partial upper case or for a double set of teeth, the process above given may very readily be modified by reference to the directions given in previous chapters for those forms of dental substitutes. It is unnecessary therefore to give any further description of the application of blocks to such cases.

The directions given in the foregoing chapters have reference mainly to the setting of teeth upon gold plate; since a full knowledge of the working of this best of all materials is absolutely essential to the dentist. But many of these processes are required in the methods of mounting artificial teeth which form the subjects of the three following chapters. In the description of these processes, we shall therefore not repeat directions already given, but confine our description to the steps peculiar to these methods respectively.

CHAPTER SEVENTEENTH.

TEETH SET UPON PLATINA WITH A CONTINUOUS ARTIFICIAL GUM.

The idea of uniting porcelain teeth to a metallic base by means of a fusible silicious composition, originated in France, where the method has, to some extent, been practiced since 1820. But Dr. Fitch, who spent much time in Paris, and was well acquainted with the French method and Delabarre's formulæ, states, that the latter had never perfected his recipes, or brought them into practical use. The composition employed there, judging from the specimens which the author has in his possession, cannot be used in connection with porcelain teeth containing as large a proportion of feld-spar as those manufactured in this country. Delabarre's compound, according to Dr. Locke, required 3761° Fahrenheit, to fuse it completely. Below this, it fused imperfectly and was found too fragile.

The process now known as the Continuous Gum consists essentially of a silicious paste, similar (except more fusible) in composition to that of which the teeth are made, which is applied around the bases and fastenings of teeth previously soldered upon a plate of purest platina, and then fused at a temperature of about 2200° Fahrenheit. It takes its name from the fact that, unlike blocks or single gum teeth, it presents an unbroken continuous gum, outside the alveolar ridge as is shown in Fig. 268. It is applied in two layers—a yellowish white *body*, giving the general contour of the gum, and an *enamel* to produce that correct imitation of the natural gum, for which nothing but ceramic materials have as yet been found suitable. Dr. Allen covers with

Fig. 268.

the same material, the entire lingual surface of the plate and also certain projections outside of the molars, and above the

cuspids designed by him for the restoration of the natural fullness of the face.

This falling in of the features is due to the absorption of the alveolar ridge, and cannot be fully restored by an artificial set of teeth, as usually made, for the reason—that if the molars were set out to the original width of the teeth, the force of mastication would fall outside the absorbed alveolus and render it practically useless. Dr. Allen's device corrects this sinking under the malar prominence of the superior maxilla, and in the canine fossa, and thus greatly aids in the restoration of the face to its original appearance.

This process was patented to Dr. John Allen, in 1851; but the priority of invention was contested by Dr. Wm. H. Hunter, in a suit, the progress and result of which are well known to all readers of the journals. Dr. Allen surrendered his patents of 1851, owing to certain defects in the same, and in 1856, a new patent was issued to him, for the process as then improved. This patent also is, we understand, involved in litigation.

The process is very generally known, as "Allen's Continuous Gum," the materials for which, as prepared by him, can be obtained at all the depots. The formulæ given in this chapter, are those of Dr. Hunter, and the earlier ones of Dr. Allen. As all such materials are more perfectly prepared on a large scale, we think it much better to purchase than to make them.

A "continuous gum" piece, made in the most perfect manner, is only surpassed in point of beauty, by the occasional productions of a very few block-carvers; but so rare are these specimens of perfection in block-work, that we may safely say, of the continuous gum work, that, when properly made, it is the most beautiful, as it certainly is the purest and sweetest, that can be worn in the mouth, so long as the porcelain covering maintains its integrity.

As regards this important point—durability, our own experience does not permit us to speak confidently. It was thought when this method of mounting artificial teeth was first adopted, that the springing of the plate in the act of mastication would cause the gum to crack and scale off; which did occur in a large proportion of the cases. Although the injury could be repaired by replacing the loss with fresh composition and fusing it to the

fractured edges of the remaining portions, and to the plate, yet this formed a very serious objection to its use. But later improvements in the strength of the compound, and also in the rigidity of the plate and soldered backings, have so far corrected this evil, that it is, perhaps, no more liable to accident while in the mouth than any other kind of work. But, out of the mouth, its weight renders it peculiarly exposed to accident, and a fall is almost certain to break one or more teeth, or crack the silicious covering of the plate. Hence, it is necessary to impress upon the patient the great importance of the most careful handling.

By uniting the teeth to each other, near their base, and to the plate by a glazed porcelanic material, the cleanliness of the substitute is most perfectly secured, as all the openings beneath and around them are completely closed, excluding the secretions of the mouth and particles of alimentary substances, which have not the smallest affinity for the porcelain. In this respect, they are superior to the most perfectly mounted block teeth; and the labor of putting up a set of the former can be performed in half the time required for making and mounting a set of the latter. A person who can mount single teeth well, may acquire a knowledge of this method, with proper instruction, in a few weeks: for, although much of the peculiar talent, required in block carving, is needed in arranging the teeth and shaping the gum for this process, yet the details are comparatively simple and may soon be taught. Of course, much practice will be required, especially in the management of the furnace heats.

The artificial gum consists, as we have stated, of two parts; the first is termed the *base* or *body*, as this constitutes the principal part of the cement, and is used for filling in between the teeth and building up the gum on the plate; the other is *gum-enamel.* The materials employed by Dr. Hunter, in the composition of his compounds are, silex, fused spar, calcined borax, caustic potash and asbestos. The silex and spar should be of the clearest and best quality, and ground very fine. The asbestos should be freed from talc and other foreign substances, and reduced to a fine powder. He gives the following formulæ and directions.

FLUX.—Take of silex, 8 oz.; calcined borax, 4 oz.; caustic

potash, 1 oz.. The potash is first ground fine in a wedgewood mortar, and the other materials gradually added until they are thoroughly mixed. Line a hessian crucible (as white as can be had) with pure kaolin, fill with the mass, and lute on a cover of a piece of fire-clay slab, with the same. Expose to a clear strong fire in a furnace with coke fuel, for about half an hour, or until it is fused into a transparent glass, which should be clear and free from stain of any kind. This is broken and ground until it will pass a bolting sieve.

Granulated Body.—Spar, 3 oz.; silex, 1½ oz.; kaolin, ½ oz.; completely fused. Break and grind so that it will pass through a wire sieve No. 50, and again sift off the fine particles which pass through No. 10 bolting cloth, which leaves it in grains about the size of the finest gunpowder. It may be made of hard porcelain, fine china or wedgewood.

Body.—Take flux, 1 oz;; asbestos 2 oz.; grinding together very finely, completely intermixing. Add granulated body, 1½ oz.; and mix with a spatula to prevent grinding the granules of body any finer.

"Enamels.—No. 1. Flux, 1 oz.; fused spar, 1 oz.; English rose-red, 40 grains. Grind English rose-red extremely fine in a mortar, and gradually add the flux and then the fused spar, grinding uutil the ingredients are thoroughly incorporated. Cut down a large hessian crucible, so that it will slide into the muffle of a furnace, line with a mixture of equal parts silex and kaolin, put in the material and raise the heat to the point of *vitrification*, not *fusion*, then withdraw from the muffle. The result will be a red cake of enamel which will easily leave the crucible, which, after removing any adhering kaolin, is to be broken down and ground tolerably fine. It may now be tested, and, if of too strong a color, tempered by the addition of *covering*. This is the gum which flows at the lowest heat, and is never used before soldering.

"No. 2. Flux, 1 oz.; fused spar, 2 oz.; English rose-red, 60 grains. Treat the same as No. 1. This is a gum intermediate, and is used upon platina plates.

"No. 3. Flux, 1 oz.; fused spar, 3 oz.; English rose-red, 80 grains. Treat as the above. This gum is used in making pieces intended to be soldered on, either in full arches or in the sections

known as *block work*. It is not necessary to grind very fine in preparing the above formulæ.

"COVERING.—What is termed covering, is made by the same formulæ as for the enamel, omitting the English rose-red. Being without any coloring whatever, it is used for tempering the above enamels when too highly colored, which may be done by adding, according to circumstances, from one to six parts of covering to two of enamel, thus procuring the desired shade. When it is to be used for covering the base prior to applying the enamel, it may be colored with titanium, using from two to five grains to the ounce.

"INVESTIENT.—Take two measures of white quartz sand, mix with one measure of plaster of paris, using just enough water to make the mass plastic, and apply quickly. The slab on which the piece is set should be saturated with water to keep the material from setting too soon, and that it may unite with it.

"MEMORANDA.—In preparing material, always grind dry, and use the most scrupulous cleanliness in all the manipulations. In all cases where heat is applied, it should be raised gradually from the bottom of the muffle, and never run into a heat. Where it is desired to lengthen any of the teeth, or to mend a broken tooth, it may be done with *covering*, properly colored with platina, cobalt or titanium.

"In repairing a piece of work, wash it with great care, using a stiff brush and pulverized pumice-stone. Bake over a slow fire to expel all moisture, and wash again, when it will be ready for any new application of the enamel. Absorption, occurring after a case has been some time worn, by allowing the jaws to close nearer, causes the lower jaw to come forward and drive the upper set out of the mouth. By putting the *covering* on the grinding surfaces of the back teeth in sufficient quantity to make up the desired length, this difficulty may be to some extent remedied.

"Any alloy, containing copper or silver, should not be used for solder or plate, if it is intended to fuse a gum over the lingual side of the teeth, as it will surely stain the gum. Simple platina backs alone do not possess the requisite stiffness, and should always be covered—on platina with the enamel, and on gold with another gold back. In backing the teeth, lap the backs,

or neatly join them up as far as the lower pin, in the tooth, and higher if admissible, and in soldering be sure to have the joint so made *perfectly soldered.*"

The compositions originally employed by Dr. Allen consist of —BODY: silex, 2 oz.; flint glass, 1 oz.; borax, 1 oz.; wedgewood ware, 1½ oz.; asbestos, 2 drachms; feld-spar, 2 drachms; kaolin, 1 drachm. ENAMEL: feld-spar, ½ oz.; white glass, 1 oz.; and oxide of gold, 1½ grs. Since the publication of the seventh edition of this work, great improvements have been made by Dr. Allen in the composition and preparation both of the body and gum enamel, which are furnished by the manufacturers and may be obtained at any of the dentists' furnishing establishments at a very moderate price.

The metals which may be employed for the base in this method of mounting artificial teeth, are, platina or pure palladium. The common commercial article of palladium is not pure, and is never used in this country. Platina, alloyed with from one to ten per cent. of pure gold may also be used, but it is objectionable from its liability to spring or warp. It makes a stiffer plate, and so far has the advantage over pure platina, but for the reason given the purest metal should be selected. Because of its softness, it must be used thicker than gold plate.

The process of swaging the plate is the same as before given. It must be often annealed, and gradually carried into any deep depressions, for its softness makes it more liable than gold to be torn, made thin, or punched through. A narrow rim partially turned up is to be left around the outside. The process of articulating, etc., is similar to that for gold.

In adjusting the teeth accurate grinding is unnecessary, but each tooth should *touch* the plate. Part of each backing should lap over the adjoining ones, and, behind the six front teeth, should also be lapped over an additional narrow band, to give greater rigidity to the plate. In this process, there is great opportunity to give to the teeth that irregularity of arrangement which forms one of the characteristics of natural teeth; neglect of which gives to many, otherwise excellent pieces of work, an unnatural, artificial appearance, that shows great deficiency in the cultivation of dental *æsthetics*.

Before backing the teeth, the piece may be tried in the mouth,

and any inaccuracy of articulation readily corrected. After they are backed, the piece should be set in a mixture of plaster and asbestos (Dr. Allen prefers asbestos to sand), resting on a muffle-slide, and coming up around the outside of the teeth to keep them in place. The solder used must contain no trace of either silver or copper, as they will stain the gum-enamel and body, but must be either pure gold, or alloyed with about five per cent. of platina. Borax may be used, not in this case as a flux, for where there is no oxidation no flux is required, but to tack the pieces of solder to place until ready to flow. The slide is then gradually carried into the muffle, and the whole piece raised to the melting point of the solder.

The form of furnace, and rules for the management of the heat, are the same as before given for block-work. The heat required for this is not, however, so great as that required in block-work; the gold and the continuous gum materials fusing at about 2200° Fahrenheit.

Having thus soldered and cooled off the piece very gradually, it must be thoroughly washed, so as to remove every particle of investment. Then with a camel's-hair brush and small knife, such as is used in block-carving, the spaces between the teeth and plate are to be perfectly filled with a finely compacted paste of *body* and rain water. The paste must be applied very moist, so as to exclude the air and run into all the spaces; then dried with cloth or blotting-paper, and compressed with the knife. If the lingual surface of the plate is to be covered, this should be made rough by soldering small clippings of platina over it, at the time the teeth are soldered. The natural rugæ of the palate should be imitated in the thin layer of body which is applied.

The work must then be slowly and thoroughly dried, and the piece put on a slide with the coronal ends of the teeth downward and imbedded to the depth of about an eighth of an inch in a thick batter of plaster and asbestos. But if the teeth are very securely soldered, it will be best to flow the body with the plate resting, teeth upward, on the plaster and asbestos model on which the soldering was done. The slide is then gradually introduced into the muffle, and subjected to a heat sufficiently high to fuse the compound—say, twenty-two hundred and fifty degrees. It is then withdrawn slowly, and completely cooled. Usually there

will be cracks and flaws which need filling with paste. The outside rim is also to be turned down over the edge of the body with hammer and pliers, and any defects at this point filled up; then heat a second time with the same care as at first.

The piece, now ready for enameling, should present a semi-vitrified appearance; if too highly glazed, it is too much done, and the enamel will not take so firm a hold; if too dull-looking, it is not sufficiently baked, and will be deficient in strength. The enamel must be applied moist, and is best put on with a brush: much plastering with the knife makes it apt to "fly" in baking, and for the same reason it must be heated *very* gradually. The layer of enamel should be thin and irregular, the yellowish white of the body showing more or less through it, so as to give the variations of tint observed in the natural gum. If a thick and even layer is applied, the result will be an unnatural uniform color, which will destroy much of the peculiar beauty of this work.

The greatest care is necessary, in applying the paste, to remove every particle from the parts of the teeth and plate which are not to be covered, as it adheres with great tenacity, and roughens and disfigures these parts. Much experience is also necessary in determining the exact heat necessary to develop the full beauty and strength of the work. Repeated heatings, either for the first making or for repairs, do not injure the plate or teeth, provided proper care is taken to heat and cool gradually; and provided, in case of repair, the piece is thoroughly cleansed in strong soda, to remove all trace of the buccal secretions.

This work is peculiarly adapted to full lower dentures. The principles of construction are precisely the same, only the plate should be very heavy, and the extra band behind the six or eight front teeth very thick and strong. Many use it for partial cases; for which, however, the author does not regard it as well suited.

The three distinguishing advantages of the continuous gum work are its ready adaptability to every variety in shape of gum and arrangement of teeth, its great beauty, and its extreme cleanliness: its three disadvantages are, its weight, its liability to be broken by accident, and its inapplicability to partial cases.

CHAPTER EIGHTEENTH.

APPLICATION OF VULCANIZED INDIA-RUBBER TO DENTAL PURPOSES.*

THE process of hardening India-rubber by combining it with sulphur and subjecting to heat, as patented by Mr. Goodyear. was in use for a number of years before its application to dental purposes was attempted. It was thus used as early as 1853. Mr. Bevan, a former employee of the Goodyear Company, Dr. Putnam, of New York, and Dr. Mallett, of New Haven, were the first persons known to the writer as engaged in these experiments. It is quite possible, however, that others were at the same time thus occupied.

Owing to the exceedingly cumbrous nature of the apparatus (Dr. Putnam's weighed twelve hundred pounds), and the absence of that knowledge of the material and those appliances for its manipulation which experience alone could give, it made, for a few years, very slow progress. It has been estimated that, in 1858, not more than three hundred dentists made any use of it; whereas, in 1863, it is conjectured by Dr. B. W. Franklin (the Dental Agent for the American Hard Rubber Company, which claims the right to all applications to the Goodyear "hard rubber" patents), that nearly, if not quite, three thousand employ it more or less extensively in their practice.

India-rubber is the concrete juice of several tropical plants, but is obtained chiefly from the *Siphonia cahuca*, growing in South America and Java. It is obtained by tapping the trees, and is at first of a yellowish-white color, but darkens rapidly on

* This chapter has been prepared by Professor Austen, at the request of the publishers, and in fulfillment of a promise once given to his late highly esteemed friend and colleague, President Harris. Into the controversies which the introduction of the vulcanite has given rise to, the writer has neither wish nor intention to enter; but will, after a brief review of the materials and their application to dentistry, give, as concisely as possible, a description of some of the apparatus and manipulations employed in this process.

exposure. It is singular that this substance, now regarded so absolutely indispensable, should have been used for fifty years (from 1770 to 1820) only to erase pencil-marks—whence its name, rubber.

When once inspissated, no known means can restore it to its original milky condition. It is totally insoluble in water or alcohol; but with strongest ether, it forms a colorless solution. In hot naphtha, it swells to thirty times its bulk; and, when triturated in a mortar and pressed through a sieve, forms a water-proof varnish for cloth. It melts at 248° F., and remains fluid without change up to 500° F., and burns, when ignited, with a bright, but smoky, flame.

Cold sulphuric acid and dilute nitric acid affect it slightly; the strongest caustic potash does not act upon it, nor do chlorine, ammonia, fluo-silicic acid and many other powerful agents; hence its great value in the chemical laboratory. Of its many uses we shall refer only to that class due to the properties developed by its combination with sulphur or sulphur compounds, selecting for description that variety of this combination prepared for dental purposes, and known as *dental vulcanite.*

The crude imported rubber is cut into minute shreds by knives set on revolving cylinders, and thoroughly washed. It is then dried and warmed and kneaded with twenty-five per cent. (by weight) of sulphur and twenty-five per cent. of best quality of vermillion. The intensity of the color of the vermillion overcomes the jet (or deep brown) black of the sulphur and rubber when vulcanized, and gives it a color more generally acceptable; it also lessens the time required for vulcanizing. The rubber, sulphur and vermillion are all opaque substances, and can never themselves, or by any combination with other substances, be made to assume any resemblance to the natural gum, which porcelain alone has, thus far, been able to imitate. The incorporation of other substances for this purpose has no other effect than seriously to impair the strength of the material. Hence, in artificial dentures, the rubber must be kept out of sight.

The question of the medicinal action of the vermillion (sulphuret of mercury) used in vulcanite, is now the subject of active inquiry. After a few years of careful observation on the part of those who know how to distinguish results from se-

quences, we shall be enabled to decide this question on what Hippocrates and Sydenham considered the only true basis of medicine—namely, experience. Meanwhile, each person interested in the question should aim to gather his quota of cases; the more extended the generalization, the more accurate will be the inferences deduced from it.

As it is an important point, and one to which the student's attention should be directed, I shall give the result of my own experience; also my reasons for doubting whether the sulphuret of mercury, in combination with the sulphur and rubber, can exercise any injurious constitutional effects ; having given the subject a very careful investigation long before my attention was called to the discussions in the journals.

First, no symptom following the use of vulcanite plates has, in any single case, come under my observation, indicating local or constitutional medicinal action; but the experience of one person, although sufficient to prove the possibility of an occurrence, cannot, by any rule of logic, establish the impossibility of any asserted statement. I shall therefore give, secondly, a few reasons for believing in the improbability of any medicinal action of the vulcanite.

Pure sulphuret of mercury is reckoned by Orfila as medicinally inert. Fumigation, by *vaporizing* the mercury, gives it a medicinal activity; but this requires a temperature of 600° F. Therefore, for the development of constitutional symptoms, we must have the presence of arsenic or of red-lead as impurities of the sulphuret; or the existence of free mercury.

First, as to the impurities of arsenic or red-lead; they are not found in pure vermillion. But even if present, such poisonous impurity would be rendered harmless, because completely invested by an insoluble coating of India-rubber. A piece of vulcanite is impervious to the fluids of the mouth; hence, no part of its substance can be dissolved, and thus taken into the stomach. Any supposed medicinal action must, therefore, come from such minute particles as may possibly be worn off the lingual surface near the teeth where bread-crusts or other hard particles of food impinge. We have thus an almost infinitesimally small quantity of vulcanite taken into the stomach, one-third of which is inert vermillion, adulterated (we will suppose)

with three per cent. of arsenic, and this coated with a layer of rubber, which, as previously stated, is insoluble in water, alcohol, alkalies, or weak acids. This very minute trace of arsenic, even if divested of its envelope of rubber, would have a purely homœopathic (and, by consequence, not poisonous) action; whilst, if encased in rubber, which pervades every part of the material, it is absolutely inert. The same may be said of the less poisonous adulteration, red-lead.

Secondly, as to the mercury, the researches of my colleagues, Professor Johnston, with the microscope, and Professor Mayer, by chemical analysis, have failed to discover the slightest trace in samples of the rubber used by me during several years. I have failed by any mechanical force to press out any globules, nor have I ever, in all my manipulations, seen the slightest particle of this metal, or been able with the microscope to detect it upon the surface of any finished piece. The one point, therefore, which I would suggest as calling for an extended series of thorough experiments and analyses is the presence of free mercury in the vulcanized material, for this I regard as the only agent that can possibly exert any deleterious action upon the system. That its presence is rare, I consider proven; but that it is *never* found, can only be, with any propriety, asserted or denied after the extended observations recommended, the observers being able to distinguish the minute crystals of sulphur from globules of mercury.

The materials of dental vulcanite are thoroughly kneaded by hand and then rolled out into sheets for use, and in this form it comes into the hands of the dentist. I shall now proceed to specify those points, in the progress of the manipulations from the impression onward, that require modification in their application to the vulcanite.

Impressions, with few exceptions, must be taken in plaster. The minute accuracy of plaster is not so essential in swaging, since the very fine lines of the model are partly lost in the die, and could not be impressed on the plate; but in the vulcanite, the faintest scratch is faithfully copied. Hence, also, the finest plaster must be used, and stirred until all air-bubbles are removed. The absolute necessity of plaster impressions, in partial cases where vulcanite is used, led me to devise the method

elsewhere described, of using gutta-percha cups. The advantages of a partial plaster impression thus obtained are—first, the exact shape of the outside of the teeth, each side the space to be filled, permits correct adjustment upon the model; secondly, the accurate shape of the outside of the molars and bicuspids, at the point where wax impressions "drag," allows the stays or half-clasps to be closely fitted to the teeth; thirdly, the precision with which plaster copies the gum enables the operator to dispense with any vacuum cavity. But it must be borne in mind, that partial impressions in plaster and partial pieces in vulcanite demand for their success the utmost care and nicety of manipulation; a care, however, which the result will fully reward.

Models require no particular shaping, except the extension of the back part an inch or more, so that the model itself may serve as one-half of the articulator. This not only saves time and plaster, but gives more accurate results: when the teeth are set in the wax plate, the model is then separated with a saw from the back part and placed in the flask. In double sets, the back part of one model is smoothed, and the T shaped groove cut and soaped; the extension of the other model is left rough, and when the articulating plates are made, the models are set into their respective plates and the space at the back part filled with plaster. Partial models containing a number of teeth require no other antagonizer than a model made from a simple impression in wax of the lower teeth, which will fit the irregularities of the teeth of the upper model. Models for vulcanite may be coated with very dilute soluble glass, but no other varnish is admissible.

Antagonizing plates are made by moulding a piece of gutta percha over the model, kept very wet to prevent adhesion. The central part of the plate should be thick to give stiffness to the plate; the rim on the ridge should be the exact length of the teeth required, and trimmed on the outside to give the proper fullness. In a lower set, the rim should be stiffened with a piece of heavy iron wire. In a full, or nearly full, upper set, the impress of the lower teeth is to be received in a thin rim of wax set on the gutta-percha. In a double set, the rims are trimmed till they touch uniformly, and then their relation marked by

indentations across the line of contact. It is quite possible, with gutta-percha plates, to take the articulation with such accuracy that no trial of the teeth is necessary, and little if any grinding of the teeth upon inserting them in the mouth.

Preparatory to grinding, the thick articulating plates must be removed, and thinner ones substituted of wax or gutta-percha; placing a little foil or thin sheet-lead upon the ridge, against which to grind and fit the teeth, except in those cases where the tooth is required to fit against the gum without any intervening rubber. The wax plate should be from the twelfth to the twentieth of an inch in thickness; and as the teeth are ground they should be tacked to it with softened or melted wax. In grinding, the greatest care must be taken to make close joints; but the fitting of the base requires none of the accuracy demanded in fitting gold plates, except when the tooth is to be set directly upon the gum.

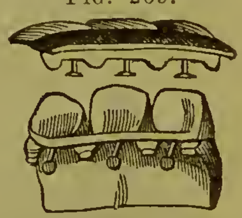
It is, however, a mistake to suppose that a space of half an inch can with perfect impunity be left between the teeth and plate. The vulcanite has a slight shrinkage on cooling. Unlike the shrinkage of metal, which is irresistible, that of vulcanite is controlled by the matrix, so that it results in no change in the shape of the plate. This is proved by the closeness with which it is seen to adhere to the model on opening the matrix. But it takes place in the direction of the thickness of the plate. If, therefore, a large bulk of material is interposed between the teeth and ridge, it will shrink perceptibly either from the ridge or from the teeth; in the first case impairing the fit of the piece, in the latter case loosening the hold of the rubber upon the tooth. It is not impossible that subsequent modifications in the time and manner of vulcanizing may correct this and several other difficulties attendant on the hardening of very thick masses of rubber; meanwhile it is safer to avoid all unnecessary clumsiness.

After grinding and arranging the teeth, the wax must be carefully worked with a wax-knife (constantly warmed in a small alcohol flame), placing wax just where the rubber is required, and avoiding, for the reason just given, all excess of wax. This process is sometimes tedious, but the time will be more than saved in the process of finishing.

All forms of teeth may be used with the vulcanite base, and, unlike most other work, may be used again and again. Continuous gum teeth can be strongly and handsomely arranged, provided the patient shows but little of the tooth. Single, plain and gum teeth require either to be backed with gold strips and soldered, or simply to have the pins lengthened. For this purpose heavy platina wire, say No. 20, should be cut into lengths, from one-fourth to three-fourths of an inch long, set between the pins in the required direction, and soldered with pure gold.

But teeth made expressly for the work are more convenient. Of these an extensive assortment is now offered by the manufacturers. The pin in these teeth is either made longer than in a plate tooth, or it is headed. The former requires to be bent and roughened, and will answer very well for blocks containing several pins. But the headed pin is to be preferred in most cases, and will hold the tooth firmly, provided it does not set too closely to the tooth, and the rubber is not too thick and clumsy. In the first case it will break away; in the second it will be loose, from the shrinkage of the mass of rubber. Fig. 269 gives a very correct idea of an excellent form of tooth, with these double-headed pins, designed and manufactured by Dr. S. S. White.

Fig. 269.



The subsequent steps are peculiar to the vulcanite process, and demand a preliminary description of the apparatus, including the vulcanizer or heater, flasks, lamp, and fixtures for packing and clamping the flasks.

From the first vulcanizing apparatus, weighing 1200 pounds, and requiring the constant care of an engineer, Dr. Putnam reduced the size and weight to a stove and boiler weighing about 350; then, in connection with Mr. Warren, he brought it down to 100, which was considered the highest improvement of cast-iron vulcanizers. The substitution of copper, first made by Mr. Brown, of Buffalo, added to the strength, reduced the weight, and permitted the substitution of flame heat for coals. Some of the vulcanizers now in use weigh only four and a half pounds.

There is a limit to all things, and this has, in my judgment,

been passed in the attempt to provide the smallest and lightest apparatus possible. Those heaters are best which will hold two or three pieces, with space around for water, which should always cover the flasks. The flasks, which ordinarily are made entirely too small, should be able to hold the largest cases with ease.

Fig. 270 represents one of the small vulcanizers of Dr. Hayes, of Buffalo, which claims to vulcanize one piece in 40 minutes, at 320°, with only one ounce of alcohol. It is a beautiful specimen of ingenuity and workmanship; but I much prefer his three-flask vulcanizers—run for a longer time and at a lower temperature. As to whether one or ten ounces of alcohol are consumed, is altogether unworthy of consideration. Not that unnecessary extravagance should be encouraged; but dental art has suffered much from that spirit of economy in the laboratory which puts 33 per cent. of alloy in gold plate, deals in cheap teeth, and thinks more of petty savings of material than of making work which, by its beauty and durability, may prove creditable both to the profession and to the practitioner.

FIG. 270.

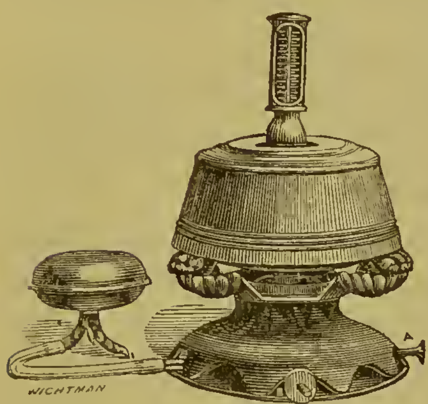


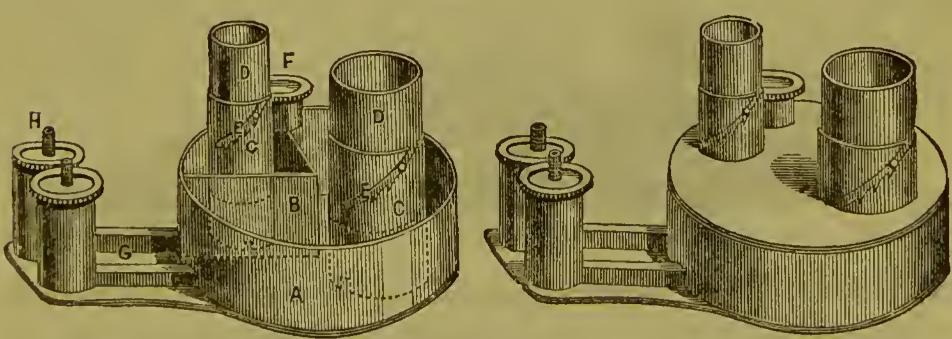
FIG. 271.

Fig. 271 represents a very simple form of copper vulcanizer, flasks and clamp which I have used for the last three years with much satisfaction. I have heated with gas and various forms of alcohol lamp; but much prefer a partially self-regulating lamp, which consumes four ounces of alcohol —two for heating up and two to maintain the heat. This lamp I devised, upon hearing a friend

describe the principle of construction of Dr. B. W. Franklin's self-regulating lamp, (Fig. 272.) It is simply a shallow tin cup, with a division across the centre; a tube runs from each half, six inches from the lamp, ending in two wicks made of bundles of finest wire spread at the top according to the size of flame required, the larger of these is for heating up, the smaller one is so trimmed as to keep the heat uniformly at the required point.

This lamp does away with the necessity of a safety-valve, as explosion is impossible. But I cannot agree with those who think that the thermometer also may be dispensed with, or that variations of a few degrees make no difference in the result. Alcohol will be found to be the best material for heating up, and a lamp like Dr. Franklin's very valuable indeed, as it makes unnecessary the constant watching otherwise required. But the progress of *every* heating should be from time to time observed. The quantity of water, the number of pieces in the heater, some accidental derangement of the metallic wick, and variations in the temperature of the room, are all modified agencies which may effect the result. Whereas, with a thermometer and occasional watching, the same degree of heat will in the same lot of rubber produce uniformly, a material having the same elasticity, color and hardness. Dr. Franklin's self-acting lamp is represented in Fig. 272, giving an internal and external view. A

Fig. 272.



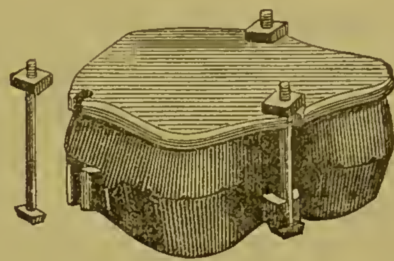
minute description of the lamp and its mode of operation can be obtained from the inventor. Figs. 273 and 274 represent the form of vulcanizer and flask, to which the size of the wicks in this lamp are adjusted.

What form of vulcanizing apparatus is best, can be ascertained only by giving all a trial. The simple forms above given, are excellent, and will yield under proper management perfect and

uniform results. Possibly others may be better; nor is it at all improbable, that inventive genius, now very busy in this branch

Fig 273.

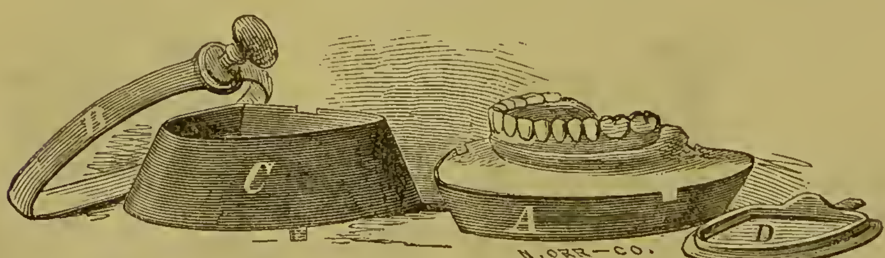
Fig. 274.



of dental machinery, will bring forth something superior to any now in use; but the limits of this chapter do not permit a full inquiry into the details of construction. I shall now give the manipulations necessary for preparing the model, with teeth arranged upon it, for the vulcanizer.

Set the model in plaster in the lower half-flask A, (see Fig. 275.) first saturating it with water to prevent the too rapid setting of

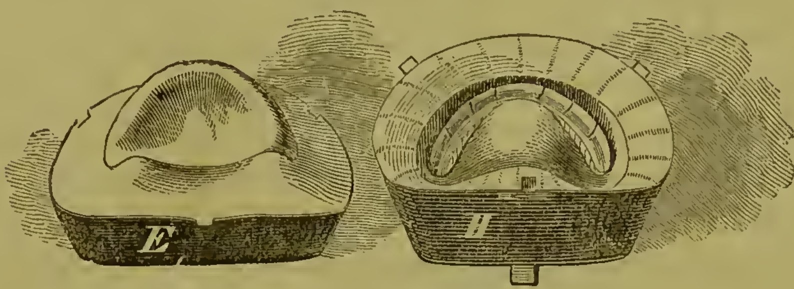
Fig. 275.



the plaster. Trim smoothly up to the model; soap this surface. or varnish and oil it, or cover it with tin foil; then set on the upper half-flask C, and pour in a thin batter, stirring it well before pouring, and working the plaster with a feather into every interstice: then set on the cover D, and apply the clamp B. Before it quite hardens, wash off the plaster with a sponge, from the outside of the flask, and let it get quite hard before separating the two halves; if there is any undercut, or in case of a thin lower ridge, warm the flask so as to soften the wax. Re-

move the wax carefully, and the flasks then present the appearance shown in Fig. 276; the model-half E separating from the teeth and

Fig. 276.



wax, contained in the dental-half H. If the joints are not very closely fitted, place a little dry plaster over each and touch with a drop of water or diluted soluble glass, and when hard, trim off the surplus plaster. Some prefer to pack with tin or gold-foil. Without some such precaution, in open joints, the rubber will press through and present an unsightly appearance.

In partial cases where no vulcanite is required outside the arch and above the teeth, I find it most convenient to carry the plaster of the model half over the teeth, retaining them in contact with the model. In which case it will be better to use the deep half H (Fig. 276,) for the model, so that the plaster around the teeth may come level with or slightly above the edge. The teeth are thus firmly fixed in their exact position, and resist displacement, which the separation of the flasks or the pressure of the rubber might possibly occasion. In this way, should the flasks chance not to come perfectly together, the result will be an extra thickness of plate.

It is desirable, however, in all cases, and quite essential in most, that the flasks should come perfectly together. This is accomplished by attention to three points: softening the rubber, using a proper quantity, and having vents for the surplus. For the *first* I use a large sauce-pan capable of holding, if required, six half flasks over about an inch of water. When the flasks are thoroughly heated by the steam, the rubber is placed on the cover of the sauce-pan, and then, while soft, packed with a pointed stick and fingers into the dental-half of the matrix. Around the teeth the rubber is packed in the form of very narrow strips with points of hard wood, somewhat as foil is inserted

into a cavity. The remainder is packed either in large strips, or in one piece cut to the shape of the wax plate.

The *second* point gives much trouble; since too little vulcanite spoils the piece, and too much requires a pressure which may break the blocks, displace the teeth, prevent the flasks from coming together, or force rubber into the joints. In most cases the quantity can be correctly found, by having the sheets of vulcanite exactly as thick as the wax plate, removing the latter as carefully as possible, and marking off its size on the former. But some irregularly shaped cases, and most lower cases will not admit of this method. In these, I advise the following simple method. Let the plate be entirely of wax; remove it all from the matrix and roll it into a sheet the thickness of the rubber; cut the rubber a little larger than this, then cut into strips and pack, bearing in mind to put most at those points where the wax was thickest.

But the *third* point must not be neglected; for the error in quantity should always be on the safe side of excess, and provision must be made for escape of this surplus by cutting vents (H), as seen in Fig. 276, that the halves of the matrix may come together without too great pressure. It is both imprudent and unnecessary to make any greater pressure than can be obtained with the thumb and fingers upon the screw of the clamp (B) (Fig. 275), avoiding excess of rubber, and having it heated to 212° Fahrenheit.

The flasks, when screwed down, are then transferred to the vulcanizing clamp (Fig. 271), and set into water in the vulcanizer. This water should be at the same temperature as the flasks, to avoid all possible danger of cracking the teeth. The top is then to be screwed on, and the heating-up flame applied. It is highly important that the vulcanizer should be steam-tight, and the packing sound and securely placed. The bursting of a good vulcanizer is impossible; but it occasionally happens that the packing, from imperfection or carelessness, blows out. The packing is often needlessly spoiled by screwing down with too much force, or when the rubber is hot. A good one, carefully used, will last six or twelve months, but it may be worn out in as many heatings.

The time occupied in heating up and vulcanizing varies with

different operators. Drs. Mallet, Putnam and other early experimenters vulcanized for six hours or more. By gradually raising the heat and reducing the time, they subsequently vulcanized in three hours at 310° Fahrenheit. More recently, the error has been to vulcanize too quickly at a high heat.

Dr. Franklin recommends heating slowly at first, bringing it in one hour up to 310° Fahrenheit, where it is to be kept uniformly for two and a half or three hours. His more recent experiments "have demonstrated, that if one hour is taken to raise slowly to 300°, and another full hour to raise steadily and gradually to 320°, *five* minutes longer will complete the vulcanizing." As thermometers vary much, and the rubber used also varies, the best plan is for every one to vulcanize trial pieces until the required hardness, toughness and elasticity is obtained. It should curl under the scraper like horn, permit bending at an angle of at least 45°, and return to its original shape unchanged. My practice is, to heat up in thirty minutes to 325° Fahrenheit, and keep it, with great exactness, at that point for ninety minutes, the vulcanizer being perfectly steam-tight and the pieces under water. New rubber, or a new thermometer, may call for a modification of these figures. Long and low heats give a better material than very quick and high heats. One hour and a half after the vulcanizing point is gained is, perhaps, as short a time as is consistent with the development of the best properties of the rubber; but the material seems equal, in all respects, to that prepared when I was in the habit of vulcanizing for three hours at 300°—310°. My experience with short high-pressure heats has not been satisfactory, and I have not, as yet, had the opportunity to test Dr. Franklin's latest suggestions. This point, however, in common with many others in the vulcanite work, is open to modification by a more extended experience.

Upon expiration of the time, the flame is extinguished and the vulcanizer cooled gradually as it stands; or more rapidly either by the escape of the steam, or by setting the lower three-fourths of the vulcanizer in cold water. The last method of rapid cooling is preferable, running the heat five minutes longer than when slow cooling is practiced. Letting off steam is a very disagreeable process, and makes the plaster of the flasks very hard to cut out. In no case should the flasks themselves

be cooled by contact with cold water, as some might chance to penetrate to the blocks and crack them.

It is best to remove the plaster, &c., from the flasks within one or two hours after vulcanizing. After that time, the plaster assumes a sand-like, granular state, and adheres with great tenacity to the plate. Tapping the edges of the flasks, after separation, will dislodge their contents in mass. The plaster can then be trimmed from the piece, taking care that it is perfectly cold. The adherent plaster in the dental-half of the flask can easily be washed from the piece with a stiff brush; but the model-half leaves a coating, that clings very tenaciously, unless means are taken to prevent it. Soluble glass measurably prevents this; but, better still, a dilute ethereal solution of collodion. Dr. Barker's preparation, sold for this purpose, answers admirably, and saves much trouble in cleaning up the piece.

The process of finishing is more troublesome than in the case of gold plate. Several sizes of round and half-round files are necessary for finishing up the edges and convex surfaces; for the concave surfaces, scrapers, graving-chisels and curved files. Sufficient thickness must be left in the body of the plate for strength, but the edges should be chamfered off. A pair of spring-callipers are required to measure the thickness of the plate, if it is to be reduced by files and scrapers. Much labor at this stage is saved by an accurate shaping of the wax. Some operators next use sand-paper or emery-cloth; others use pumice-stone on cork wheels; I always use, and very decidedly prefer, Scotch-stone. The third step is the use of rotten-stone (not tripoli, which cuts with too keen a grit), either on a brush wheel, with tallow or oil, which is the more rapid process; or on a stick of some hard wood, with water, which is the more cleanly. A little oxide of zinc on a soft wheel, or on the finger, will give a brilliant finishing polish, but is not essential, as the rotten-stone can be made to polish very highly.

After trying the piece, and finding that no part of the edge requires alteration, a bright surface-color may be given by placing the piece in alcohol and exposing to the sun's rays for six or twelve hours. Some regard this an improvement. It certainly does not injure the quality of the plate, but my own taste prefers the original mahogany color to the bright vermillion tint thus given.

In partial cases, it will prevent accident if, after filing the edges, a lump of gutta-percha is fitted to the palatine surface of the plate. The subsequent operations can be conducted more rapidly, and with less danger, in delicately-shaped pieces. Vulcanite is softened by heat; hence a piece is sometimes bent by revolving the brush-wheel too rapidly. A piece that has been in any way bent or warped, may be restored by heating either in boiling salt water, or in oil to about 220° or 230°. While soft, it may be bent with the fingers; but, as this guess-work method is hazardous, it is much better to bind it down upon a model, which is also warmed.

Vulcanite plates do not require, either in full or partial cases, any vacuum cavity; but it may be well, in some full cases, to relieve the pressure upon a hard palate, when combined with a soft alveolar ridge. This may be done by cutting away the impression, building a layer of plaster on the model, or cutting out the vulcanite. The last method is the best, because it can thus be done only when found necessary. The second method is, to cover the inside of the model with a thin wax plate, cut out the size of the cavity, roughen and wet the model at this place, and apply a thin layer of plaster; when hard, remove the wax, and if necessary trim the plaster projection.

Vulcanite work may be repaired by removing the broken tooth or block, cutting dovetails in the rubber, and then filling the space with the new teeth, arranging the wax and vulcanizing as at first. The part of the plate under the broken teeth should be filled with plaster, and then removed so as to preserve the shape of the ridge in case the process of repair requires that the plate shall be cut entirely through at this point: it is to be replaced before applying the wax.

The second heating darkens the old rubber, and makes it more brittle; but full cases will admit of one, possibly two such heatings. Partial cases should be repaired either by replacing the entire plate with new rubber, or riveting on a gold or platina slip, to which the new tooth is soldered. I decidedly prefer, in both full and partial cases, the entire replacement of the rubber. In doing this, there are various ways of securing the correct relation of the teeth to the new model. I shall name only two.

First, in cases where the plaster model can be drawn from

the plate—fill the palatine surface of the plate after a very slight oiling; let the model have a projecting flange outside the arch; soap or varnish this flange (which should have depressions cut into it), and run plaster upon this and against the outside of the teeth: remove this plaster rim, then heat the plate in a sand-bath or hot oil, and take off the teeth; adjust the outside rim of plaster to the model, set the teeth in their respective places, and apply wax, etc., as at first, and prepare for vulcanizing. Sometimes in partial cases gutta-percha may be used instead of plaster to secure the relation of the teeth to the model. The central portion of the old plate may be generally used again instead of a new wax plate.

Secondly, in cases where the model cannot be drawn from the plate, and also in those cases where, from defect in the first impression, a new one is necessary. In some partial cases, the new plaster impression gives a model which makes a second arrangement of the teeth perfectly easy. In other partial cases, and in full sets—run a plaster rim around the outside of the teeth; remove it, and then soften the plate and detach the teeth; replace the teeth in the plaster rim, then bend a stout iron wire so as to touch along the inside of them, and fasten each tooth or block to the wire with cement (resin, gutta-percha and plaster); remove the plaster rim, then set the teeth upon the new model, and arrange new wax plate, etc.; detach the wire with a hot wax-knife, and chip off the fragments of brittle cement as gently as possible, so as not to derange the position of the teeth. Special cases will call for modifications of these processes, of which the limits of this chapter will not permit a description. This method of repairing by the substitution of a new plate (although sometimes very simple) is often but little less troublesome than the original work, the only labor saved being in the grinding of the teeth.

Partial pieces can usually be retained by stays and the fit of the plate. If clasps are called for, these may be made in some cases of rubber alone; but still better of rubber strengthened by a gold wire, which is to be placed around the clasp-tooth, just before packing the rubber. A gold clasp may also be fitted and retained in the rubber, either by a projecting slip of the same metal, or by soldering into it one or two platina pins.

Blocks or gum teeth may be secured to gold plate by vulcanite instead of soldering. One method of doing this has been made the subject of a patent by Dr. A. M. Asay & Son, of Philadelphia, the details of which can be obtained by reference to them. Blocks with holes passing partly or entirely through the teeth, can be very firmly secured by vulcanite. Solder roughened or headed pins into the plate opposite each hole; fasten the blocks temporarily with wax, then invest in the vulcanizing flasks, so that on separating the matrix the plate shall come away in one half, the teeth in the other; fill the holes with rubber, and place a strip over the base of the blocks; warm and replace the two halves of the matrix, and vulcanize.

Vulcanite blocks may be set on gold plates thus—grind and fit accurately to the plate; run a plaster rim on the outside of the blocks, then remove the wax and mark on the plate proper points for the insertion of platina loops or headed pins; remove the teeth and solder these loops or pins into holes punched or drilled in the plate; re-adjust the teeth in the plaster rim, and fasten them in place, with wax trimmed to the shape required for the vulcanite; then invest in the flask and vulcanize as before described.

This is a very useful application of vulcanite. It loses one of the peculiar advantages of the vulcanite, the accurate fit of the plate. But it makes very strong work, and is more cleanly than ordinary swaged work because all interstices are so completely closed. It obviates two of the principal objections urged against vulcanite—thickness of the plate, and contact of the rubber against the gum and tongue. It also dispenses with the accurate grinding of the base of the blocks, required in ordinary gold work, and obviates the risks of the soldering process. I think that by the use of an outside band, either swaged or soldered, and a soldered inside lining, thus showing merely a narrow line of rubber, the greatest opponent of the vulcanite would find this one of the very best means of securing blocks or gum teeth to gold plate, for all full cases and those partial cases where three or four teeth are grouped together.

Of the peculiar adaptation of the vulcanite material to the correction of irregularity mention has been made on p. 160 of

this work. No further special directions are required, except on two points: first, to have the plaster which makes the model perfectly smooth and free from air bubbles; secondly, to coat the teeth before vulcanizing with Barker's solution. Attention to these two points will give a plate, that, if the impression is correct, will fit the teeth with most perfect accuracy.

It remains briefly, to refer to the application of the vulcanite to the pivoting of teeth. Several methods of doing this are given by Prof. J. Richardson in the April No. of the *Dental Register*, 1862, to which the reader is referred. My own method is concisely as follows—prepare the root as elsewhere directed in this work, (p. 615,) being careful to drill the hole in the root. as smoothly and uniformly as possible; wrap some gutta-percha around a small piece of wire, pass into the pivot hole and harden it by applying cold water on a piece of cotton. The piece of gutta-percha may either be large enough to cover the base of the root or may be removed and trimmed to the size of the hole, a looped end of the wire being left projecting below. Now take carefully a plaster impression of the space and two adjacent teeth, let it get very hard, then withdraw it. The gutta-percha pin is held in the plaster by the wire loop and drawn away with it. A plaster model is made from this, the plaster impression very carefully removed, and the pin softened and removed from the pivot hole.

This model, made of finest plaster and well mixed, is hardened with dilute soluble glass, and forms the basis on which to adjust and finish any kind of tooth that may be thought best, or that the shape, size or direction of the pivot hole in the root may require. Selecting a vulcanite, plate or pivot tooth, it is ground to fit accurately in front. If a pivot tooth is used, I prefer to grind the lingual surface with a very small wheel, until the pivot hole is opened through the tooth. Then pass a gold wire through the tooth into the plaster pivot hole; arrange the wax, set the case in the flask, separate, pack with rubber and vulcanize. In case of a plate or vulcanite tooth, set the wire in the hole in the plaster and cover the part projecting with wax built against the back of the tooth.

If the canal in the root is large and I wish to line it with vulcanite, I take a gold pin perfectly cylindrical and highly

polished and roughen the part below the root; then set the polished end centrally in the hole in the plaster and proceed as before. When vulcanized and finished up, I cut with a sharp knife around the base of the pin down to the gold pin and then insert the piece in the mouth. Should it be necessary to remove the tooth, the smooth gold pin will draw from the rubber before the detached cylinder will draw from the tooth.

Again, should I prefer to use the wooden pivot, I take a small polished brass or steel pin that fits the root exactly, but not tightly; with this set in the hole in the plaster and projecting one quarter of an inch or more, proceed to arrange wax, and vulcanize as before. When polished up, the metal pin is replaced with compressed hickory and inserted.

The use of vulcanite in pivot teeth gives greater firmness by exactly fitting the base of the root. By thus excluding the secretions, it also removes another objection to pivoting. The method above recommended enables the operator to complete the work, after taking the impression, in the absence of the patient, and yet with absolute accuracy.

Upon the completion and insertion of a vulcanite piece, the patient should be cautioned to cleanse it at least once a day with a stiff tooth-brush and water. Extreme cleanliness is advisable in all kinds of artificial work, and many patients need no such direction. The special necessity for this in the case of vulcanite arises from the tenacity with which the mucous secretions of the mouth adhere to the surface if, from neglect, they are allowed to collect upon it. It is most apt to collect at those points where the friction of the tongue and of the food does not prevent it. The same care is necessary for its daily removal as is required to keep the natural teeth in good order. There is, however, this difference between cleanliness of the teeth and of the plate, that while both are essential to purity of the mouth, the secretions have no chemical action upon the plate, as they have upon the teeth.

There is one point affecting the durability of vulcanite plates which it remains for subsequent experience to settle. It is well known that silver and eighteen-carat gold undergo a change in the mouth, which causes them to become more or less brittle.

This is not the case with twenty-carat gold and with platina. A similar change is noticeable in the gutta-percha which is used for impressions, and is found, also, in the vulcanized gutta-percha and in those preparations of vulcanized rubber with which foreign substances are largely mixed, in the vain hope of giving it some resemblance to the natural gum. I have failed, as yet, to detect it in the "Goodyear compound" of India-rubber, sulphur and vermillion. But this point requires the collected experience of many observers, carried over a period of years, carefully distinguishing between the brittleness of over-baking or twice vulcanizing, and that which may supervene as the result of certain molecular changes in the substance of the material. It is a change which, unlike the galvanic change in gold and silver plate, does not require the presence of the buccal fluids; but will take place equally out of, as in, the mouth, as is shown in the case of gutta-percha. It is a point, also, which is, doubtless, much modified by the manner of vulcanizing. Slow and careful vulcanizing will, probably, give entire freedom from the liability to become brittle by age.

In conclusion, it may not be amiss to give, briefly, the present status of the vulcanized rubber process. Upon the subject of patents in general or the validity of special patent-rights it is not necessary to express any opinion. This is purely a question of law and political economy, with which dental teaching has nothing to do. But it has much to do with the inquiry into the merits of a process, the use of which has spread during the last three years with an unexampled rapidity, eliciting, on the one hand, unqualified approval; on the other, unsparing condemnation.

Against the use of the vulcanite it is urged: First. That it degrades the art, by the temptation it offers for cheap work, and by the ease with which its peculiar manipulations are performed. Second. That its medicinal action upon the system is such as renders it an unfit material to be put into the mouth. Third. That it produces an unpleasant burning or heating sensation in the mucous membrane, and a permanent sponginess of the gums, not found after the wearing of metallic plates. Fourth. That the mucous secretions require more care for their removal from

the surface of the plate than most patients are in the habit of giving; hence the liability of the piece to become unpleasant. Fifth. That, to give the necessary strength, requires a thickness of plate that is clumsy and interferes with distinctness of enunciation. Sixth. That the work becomes brittle in the course of a few years. Seventh. That it is troublesome to repair in such a way as to maintain its original strength.

In favor of the use of vulcanite, it is urged: First. That the absolutely perfect and unfailing accuracy of its adaptation to the model places it, in this important respect, before every other material in use for dental plates. Second. That, being perfectly impervious to fluids and insoluble, it is a pure and harmless material. Third. That, being devoid of all galvanic action, it is more agreeable to patients than soldered and alloyed plates. Fourth. That it has none of the wearing action of metal upon teeth, against which it becomes necessary, in partial cases, to bring it in contact. Fifth. That the great lightness of the material makes it very pleasant to the patient, and permits the filling out of deficiencies in the ridge with the least possible addition to the weight of the piece. Sixth. That this lightness, together with its peculiar elasticity, lessens greatly the danger of accidental breakage of either teeth or plate; thus making it, when properly constructed, the strongest of all dental substitutes. Seventh. That the plastic properties of the vulcanite and the readiness with which it may be moulded and hardened against any surface, however irregular, give it a wider range of applicability than any other substance used in dentistry.

As stated at the commencement of this chapter, it is not my purpose to discuss any of these points further than they have been necessarily referred to in the description of materials and processes. None of them can be settled by argument, and the amount of experience as yet collected is inadequate to decide them all.

Present manipulations, materials and apparatus in this comparatively new process will, doubtless, be more or less modified, and some of the objections now urged, with more or less truth, against its use will be done away with. But so valuable are its peculiar properties, that the vulcanized India-rubber, in some form or mode of application, must, unquestionably, become *inseparable*

from dental practice. Its introduction forms one of those marked eras in dental prosthesis, prominent among which may be mentioned—the manufacture of porcelain teeth; the use of metallic swaged plates; the use of plaster for impressions; the application of the principle of atmospheric pressure; the continuous gum work; lastly, the vulcanite. Neither the material itself, the process of hardening, nor the apparatus used are, as yet, perfect, and the various applications of this valuable substance to dental purposes are as yet but partially known. The ignorant and unskillful will do it discredit by badly working and by misapplying it. Meanwhile the scientific and philanthropic practitioner will patiently investigate its properties, in the hope that, perchance, it may supply some want of suffering humanity which dental art has, as yet, been unable to relieve.

CHAPTER NINETEENTH.

CHEOPLASTIC PROCESS.*

Among the peculiar advantages claimed for the Cheoplastic method of mounting artificial teeth over the usual method with swaged-plates, are perfect accuracy of adaptation of the plate to the plaster model, (metallic castings not being used in this process,) and greater practical usefulness and durability: also that it can be done in less time, and that the material used in this process is less expensive. This material is an alloy, the precise composition of which we have never taken trouble to ascertain, as it can be obtained from the manufacturer, and at most of the dental depots, of a better quality, we presume, and at a lower price than it can be made in small quantities. It is, however, composed principally of tin, silver and bismuth, with a small trace of antimony: the exact proportions of which may be seen in the specifications which accompany the application for the patent. The alloy imparts no taste whatever to the mouth, and its purity, so far as its capability of resisting the action of the secretions of the buccal cavity is concerned, is said to be fully equal to that of eighteen carat gold. Its color, after being worn some weeks, becomes slightly darkened, but is immediately restored by placing it in a strong solution of caustic potash. This is the only change we have ever observed, and we have seen it after having been worn in the mouth nearly two years.

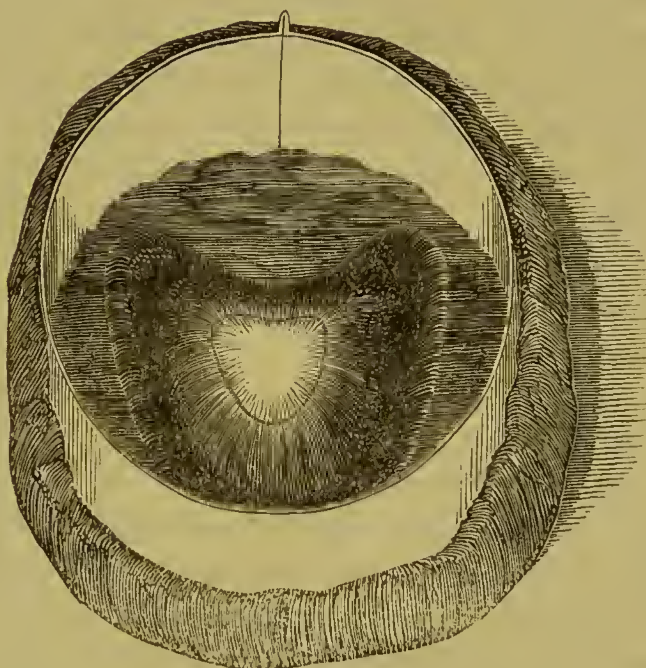
This method of mounting teeth has only been practiced since the fall of 1855, and it was not made known to the profession generally until February, 1857. Since this time, it has been more or less adopted and practiced by nearly three hundred dentists, among which number are many of the most skillful

* We had hoped to receive from Dr. A. A. Blandy, the patentee of this method, a statement of the improvements made by him in the alloy and manipulations peculiar to his process. But he was unexpectedly called from the country and his emendations cannot be received in time for the present edition. The chapter is therefore reprinted, with a few verbal alterations, as it appeared in the last edition.

practitioners in the United States. Thus far we believe it has fully realized the expectations of its most zealous advocates, and judging from the testimony of others, as well as from results which have come under our own observation, the use of it seems likely, in a very short time, to become general.

In mounting artificial teeth by the Cheoplastic process, the first thing is to take an impression of the mouth either with wax

Fig. 277.



or plaster of paris. If it is desired to have a central chamber or cavity in the base, with a view to make it adhere more firmly to the parts against which it is to rest, one of the right size, depth and shape, is cut at the proper place in the impression; this, if of plaster, is varnished, then placed on a piece of paste-board or paper, and surrounded with soft putty, dough or clay, or any other plastic substance. A tin ring is then placed over it, (the lower edge slightly imbedded in the putty,) large enough to leave a space of about half of an inch all around between the impression and the ring, except at the back part, where it should be an inch and a quarter at least, for the formation of an articulating surface for the two parts of the matrix, and that it may also be used for the antagonizing model. The ring should be about an inch or an inch and a half in depth. See Fig. 277.

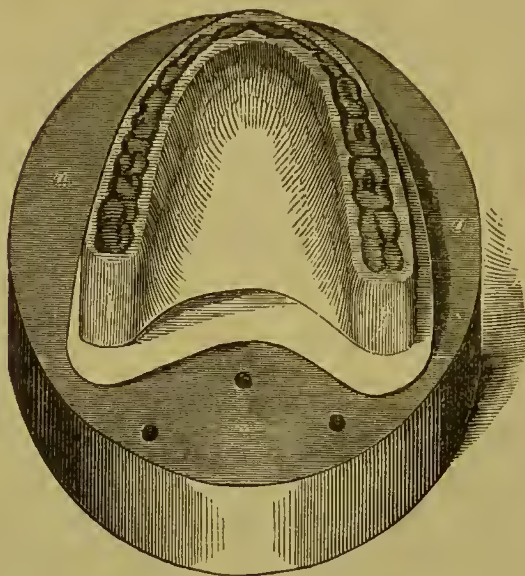
The model is made of equal parts, by weight, of plaster of

paris and finely pulverized spar, mixed with pure water until of the consistence of thin batter. This composition is not so hard as plaster alone, but it is sufficiently solid for all practical purposes. If desirable, the density of the surface may be increased by the use of dilute soluble glass. The impression and surface of the putty, as well as the inside of the ring being oiled, the mixture is poured in, stirring it with a camel's-hair pencil or feather, until it is raised to a level with the upper edge of the ring. As soon as it becomes sufficiently hard, the ring and putty are removed, and the model carefully separated from the impression, which, when the alveolar border has no undercut, may be done without injury to either. Half a dozen or more models can often be taken from the same impression. When the alveolar ridge projects, it is sometimes necessary to cut away the outer part of the impression before the separation can be effected, but when this is done, care is necessary to prevent injuring the model. Having removed the model from the impression, the portion designed for the formation of the chamber in the base may be altered, if desired, and made smoother before proceeding further with the operation.

The next thing to be done is, to make an antagonizing model, and as the method of obtaining it for this process is different from any heretofore given, we subjoin a brief description of it. Two or three conical holes are made in the back part of the model for the proper adjustment of the antagonizing portion, (see Fig. 278, in which the artist has represented the holes entirely too small,) a coating of varnish is applied to every part except that which is to be covered by the base for the artificial teeth. This part is now covered with a plate of thick tin foil, stiffened by the application of a sheet of soft wax to the part within the arch. This may be a quarter or three-eighths of an inch thick, and when it has hardened, a rim of softened wax is placed along the alveolar border and trimmed down with a knife until its width is a little greater than the length required for the artificial teeth. Remove this and the stiffened tin foil plate together, place them in the mouth before the wax hardens, and if the rim is of the right width all round, request the patient to bite upon it, closing the lower jaw naturally, until a distinct imprint of all

the lower teeth is made in it. (See Fig. 278.) This done, the wax and plate are removed from the mouth, replaced on the

Fig. 278.



model, and the lower half-model made in the manner described in a preceding chapter.

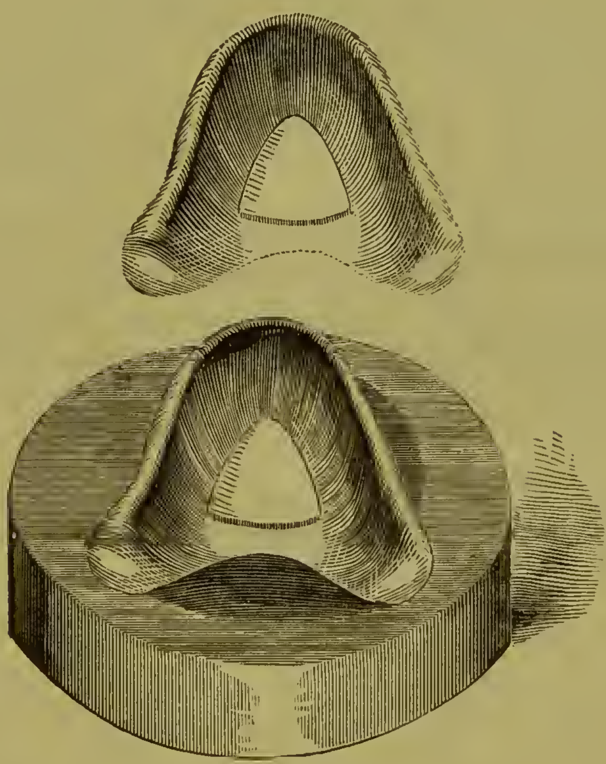
After the lower half-model, the wax and tin foil have been removed, the portion of the model representing the alveolar ridge and roof of the mouth, is covered with a fresh plate of tin. This is accurately moulded to the various depressions and prominences with the finger, and with hard rolls of chamois leather, cut nearly to a point at each end, called *stumps*, (Fig. 279,) such as

Fig. 279.

are used for shading drawings. One or two extra strips of foil may be placed over the prominent parts of the alveolar ridge to secure sufficient thickness of metal at those points between the teeth and gums. A plate of sheet wax, rolled to the thirtieth or fortieth part of an inch in thickness, is put over the tin, covering only so much of the model as is to be occupied by the metallic

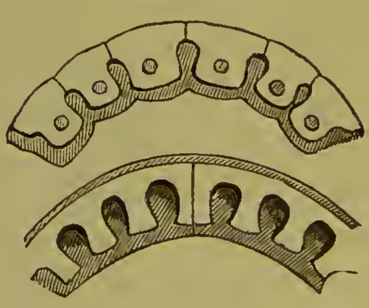
base. This is carefully and accurately moulded to the tin-foil plate, and then trimmed to the required size. Fig. 280 shows the model and wax plate separated.

FIG. 280.



The teeth are now selected and arranged upon the wax plate of the model. Gum teeth, either single or in blocks of two or three, are preferable. As they are arranged upon the model, the approximal sides are ground until the teeth or blocks come together so perfectly at every point as to render the line of union scarcely perceptible, no paper being required between the joints, as in the soldering process. The teeth used in this process are constructed differently from those designed for swaged plates. They are not provided with platina pins in their palatine surface, but have holes or dove-tail grooves into which the metal runs, retaining them securely to the base. A sectional view of single and block teeth designed for this process is given in Fig. 281,

FIG. 281.



the shaded line representing the metal. But plate teeth can be used and attached very securely by bending the platina pins until the ends come together. Dr. Sheppard, of Virginia, had made by Messrs. Jones, White & McCurdy, and uses for this process, a form of tooth with platina pins, very similar to those now used for the vulcanite work. As it is not a matter of any importance whether the base of the teeth fit closely to the wax plate or not, it is rarely necessary to grind them here, except when the teeth are too long.

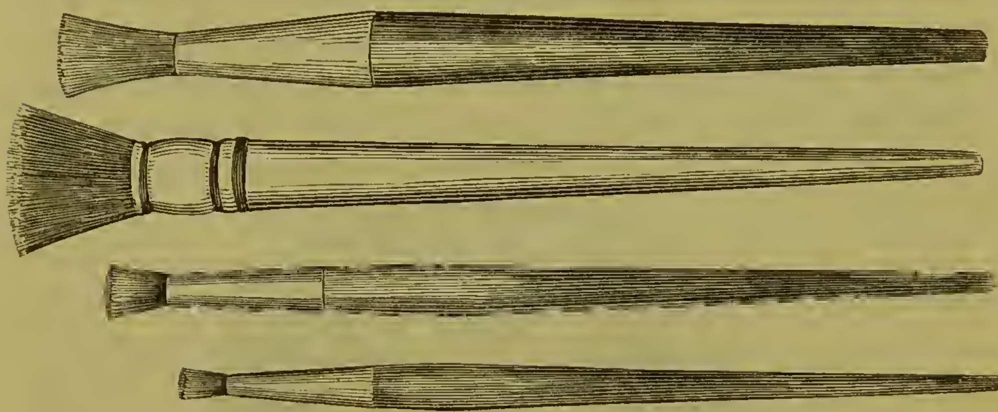
Each tooth or block, after having been properly ground, is made fast to the wax plate by applying melted wax to the palatine surface, which fills the holes or grooves and runs down and unites with the plate beneath. The instrument constructed for this purpose (Fig. 282) is to be previously warmed in the flame

Fig. 282.

of a spirit-lamp. The two halves of the antagonizing model are, from time to time, applied to each other as the teeth are arranged, in order to insure accuracy of adjustment. When proper care is taken, it will seldom be necessary, if the bite of the lower teeth has been correctly taken, to make any alteration in the piece after it is put in the mouth. The amount of wax applied to the backs of the teeth, after the grooves or holes are filled, should equal the amount of metal required to unite them firmly to the base. This may be done by putting a narrow strip extending all the way round the inside of the arch, or it may be applied in small pieces, in either case using the wax-knife (Fig. 282) warm, to unite the strip or pieces to the teeth and wax plate. Another strip is next applied along the upper edge, on the outside of the teeth, filling the groove above the gum, and uniting it to the teeth and plate with the wax-knife. This strip should be long enough to pass behind the last tooth or block on each side, and unite with the wax applied along the lingual surface. As metal is ultimately to take the place of the wax, it is important that the exact quantity required be put on, and every part made perfectly smooth. This may be done with the warm wax-

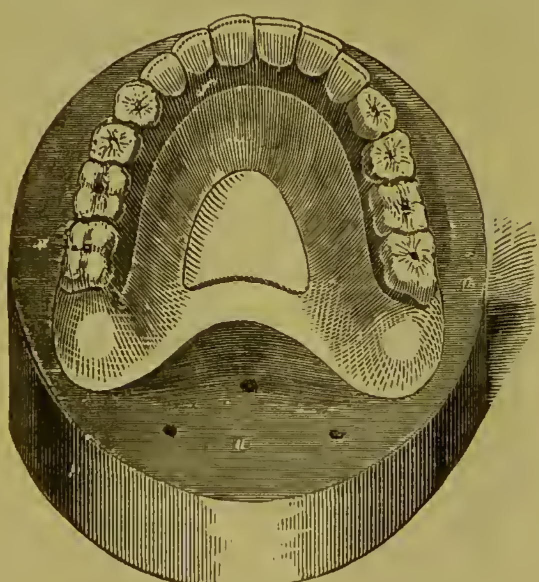
knife and brushes like those represented in Fig. 283. The larger ones are designed for pressing it down upon the model, and the

Fig. 283.



smaller for smoothing it between the teeth, and where the wax-knife cannot be conveniently employed. The smoothing process may be facilitated by throwing the flame of a spirit-lamp lightly over the wax with a very finely-pointed blow-pipe, slightly melting the surface and giving it a beautifully polished appearance. In proportion as this part of the operation is neatly and skillfully executed, will the labor of finishing, after the metal has been poured, be lessened.

Fig. 284.

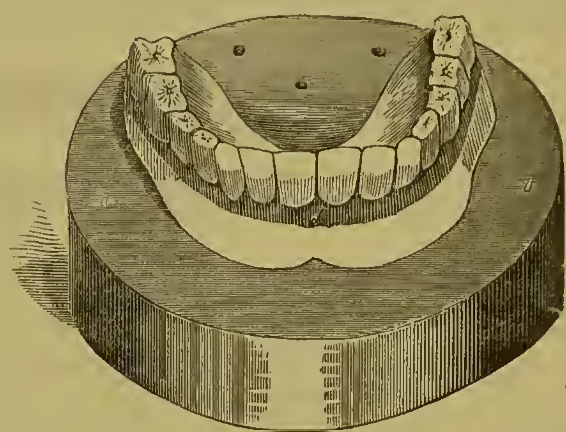


An upper set of single gum teeth, thus arranged on a wax plate upon the model, is represented in Fig. 284. If there is any doubt with regard to the proper adjustment of the teeth, arising

from fear that the bite of the lower teeth into the rim of wax was not natural, the piece may now be tried in the mouth; and should any alteration be necessary, it must be made before proceeding further with the work.

When single teeth without gums are used, the strip of wax in front and on each side is pressed between them and a festooned appearance given to it like the natural gum. A set thus pre-

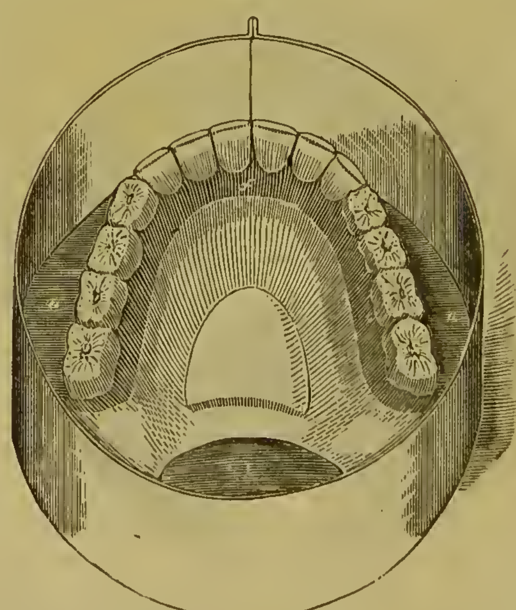
FIG. 285.



pared, is represented in Fig. 285, giving an external view of the festooned wax band.

The work is now placed in the tin ring in which (Fig. 277) the model was made—the upper edge of the ring projecting about

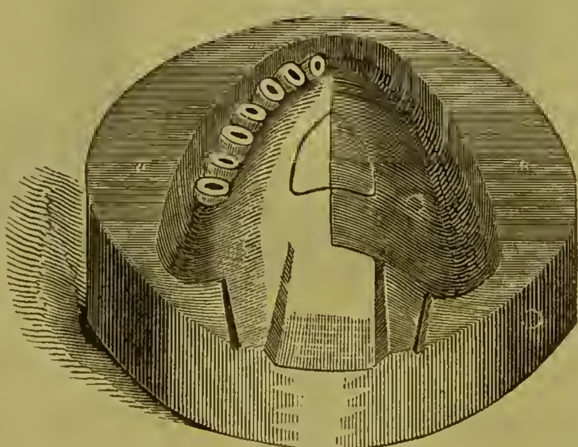
FIG. 286.



a fourth of an inch above the summits of the teeth, as shown in Fig. 286. The exposed surfaces of the model inside of the ring

and of the wax, (but not of the teeth,) are to be well oiled, and a mixture of plaster of paris and spar, in the proportions above given, are now made into a thin batter, and poured on gradually, until the ring is filled, stirring with the brush or feather as before directed, to drive out air bubbles, and ensure a perfect cast. When the mixture becomes hard, the ring is removed, and the part of the matrix first made is tapped lightly with a small hammer or mallet until the one loosens a little from the other, when the two may be easily separated with the hands: but if there be any undercut, thin ridge, or teeth, the matrix must be warmed before separation, so as to soften the wax. This done, while the composition is comparatively soft, a groove or gate and on each side of it two vents are to be cut in the back part of the matrix, which contains the teeth and wax plate; through which gate the melted alloy is to be poured, the air escaping through the two vents. Fig. 287 represents the gate and vents, also one-

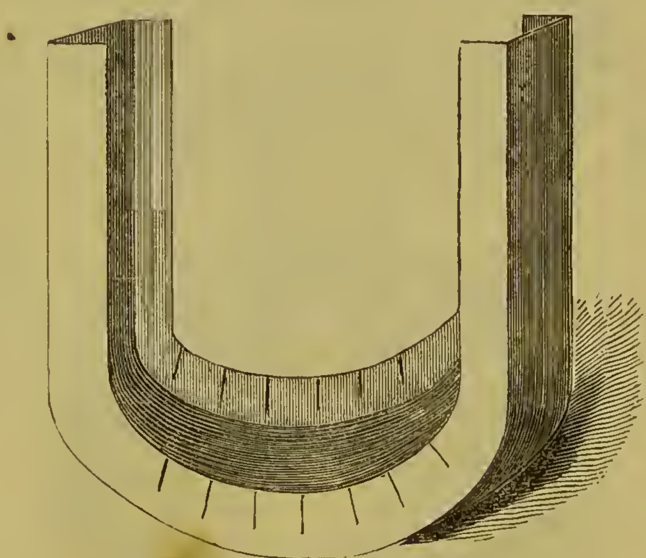
Fig. 287.



half of the wax plate removed, showing the ends of a set of plain teeth. All necessary trimming of the plaster is done before the wax is removed, to prevent small pieces from falling in the matrix by the sides of the teeth. The wax is now removed as perfectly as possible, as the absorption of any considerable portions left in the matrix has a tendency to roughen the surface, and thus to prevent the metal from running as smoothly as it would otherwise do: but in the attempt to remove the minute pieces, the excavator will often roughen the surface and force fragments of plaster into places from which they cannot be removed: these small remnants of wax will totally disappear in

the process of heating up. After removing the wax, each half of the matrix is held over the flame of a tallow candle, until a slight coating of lampblack forms on it. The two parts are now put together and firmly united by passing an iron wire two or three times around it, and made fast by twisting the ends tightly together. The line of union is next luted with a mixture of plaster and spar, leaving the gate and vents open. This is necessary to prevent the metal from escaping when poured; but this sometimes requires additional means of security. The simplest and perhaps the best is, after wiring and luting the matrix, to put it, with the gate and vents upward, into a sheet-

Fig. 288.



iron or tin box, (see Fig. 288,) partially filled with a thick batter of plaster and spar.

Thus secured, the piece is put into a small gas sheet-iron furnace, or into a kitchen range or bake oven, and exposed to a bread-baking heat, say from 300° to 400° Fahrenheit, for from three to five hours, or until every particle of moisture is driven from it. It is then placed in an upright position, the metal melted, and while at a temperature sufficiently high to make it assume a light blue color is poured quickly into the matrix. If it does not bubble, and comes up into the vents freely, the piece will come from the matrix in a perfect condition. If it bubbles it may be tapped several times lightly on a brick or some hard substance. When perfectly cold, the two parts of the matrix

are separated, exposing one of the surfaces of the plate. If any part is found defective, this is the proper time to repair it: which is done with solders Nos. 1 and 2, prepared for the purpose,* muriate of zinc being used as a flux. This latter is applied to the defective part on the end of a small piece of wood: a sufficient quantity of solder is then placed on the defective part and a small jet of flame from a spirit lamp thrown lightly on it with a very finely pointed blow-pipe. As soon as the solder flows freely and smoothly, the projection of the flame is immediately discontinued, else the plate will be melted.

But when the process is properly conducted from the beginning up to the point of pouring the metal, the piece will come from the matrix perfect in all its parts; and when the metal fails to flow freely around the teeth and to cover perfectly the alveolar border and palatine arch, it is better to melt it from the matrix with the flame of a spirit lamp projected upon it with a blow-pipe, using the precaution not to concentrate the flame too long on the teeth, as in this case there would be danger of cracking them. When this is done, the matrix is secured as in the first instanee, luted, dried and the metal again poured.

Before removing the piece from the half of the matrix which holds the teeth, the cavity in the plate, if one has been formed, is made smooth with scrapers and polished with prepared chalk on a brush-wheel revolved in a lathe. The remaining half of the matrix is now removed, and the edges of the plate properly rounded with a coarse file; the asperities of the exposed surfaces are removed with scrapers made for the purpose, and if necessary, the thickness of the palatine portion reduced. This done, these surfaces are rubbed first with coarse and afterward with fine emery cloth, then washed in soap and water, with a hard brush, afterward burnished and finished by polishing with chalk on a brush-wheel. The upper surface of the plate must not be scraped or polished, as the accuracy of its adaptation to the gums and palatine arch would be injured by it, but simply washed well

* The above solders are furnished with the alloy used for the base. No. 1 is prepared for use by melting and pressing it, while hot, between two smooth flat surfaces. No. 2 is made into thin plates by passing through a rolling mill. The flux is made by dissolving pure zinc in muriatic acid until the acid can take up no more of the metal. This flux improves by age, and should not be used, if possible to avoid it, for three months.—*Book of Instructions for Mounting Teeth by the Cheoplastic Process.*

with a brush, using perhaps a little whiting; every other part, however, ought to be finished in the neatest and most perfect manner. The polishing up to this point being completed, the piece is put into a strong solution of caustic potash, boiled for two or three minutes, then washed in pure water, wiped dry and finished by re-polishing with chalk and the brush-wheel.

If the piece is to be gilded, it should be first put in the mouth and worn a few days, to ascertain if the adaptation is perfect, as any future alteration would deface it and render a second covering of gold necessary. The adjustment being correct, the piece is cleansed from the secretions of the mouth and all foreign matter, by boiling again in a solution of caustic potash and washed in pure water; it is then polished with chalk. washed and put into the "gilding solution;" during the deposition of the gold, it should be removed several times, burnished and polished to give solidity to the plating, and remedy any defect that may be discovered. After a sufficiently thick coating has been deposited, say from three to five dwts., it is finished as in the first instance, by burnishing and polishing.

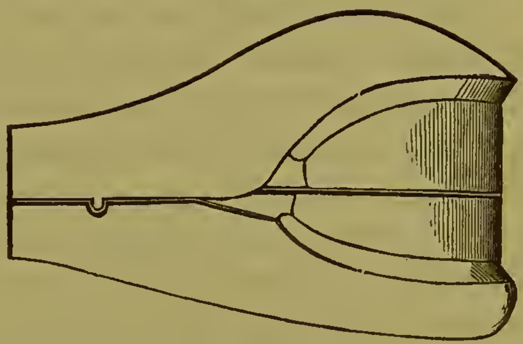
The practical value of a piece is not enhanced in the slightest degree by gilding, as the alloy is tasteless and is not acted upon by the secretions of the mouth. Indeed, unless the deposit of gold is tolerably thick and perfect at every point, it is productive of injury, by exciting a very decided galvanic action. As a general rule, therefore, a piece may be said to be much better without than with it. For a description of the process of electro-gilding, the reader is referred to works devoted especially to the subject.

In mounting a set of teeth for the lower jaw by the Cheoplastic process, the gate through which the metal is poured into the matrix should have two lateral branches, one on each side, to admit it more freely than one can be made to do. The wax plate should also be thicker, to give sufficient strength and stability to the base, but in every other respect the method of procedure is almost precisely the same as that described for an upper set. For a partial lower set, say for the molars and bicuspids on each side, the wax plate should be extended behind the remaining front teeth, and two or three thicknesses may be applied here to stiffen it sufficiently to prevent it from breaking

or bending when pressure is made on the teeth of the base on each side.

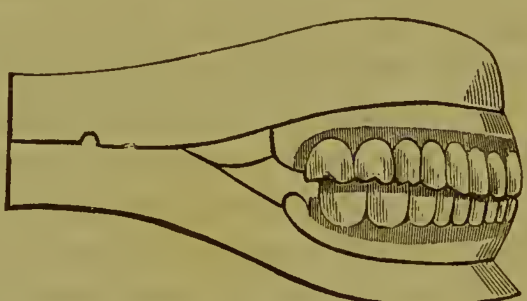
In making an antagonizing model (Fig. 289) for an entire set of teeth, the wax plate for the lower jaw is stiffened by the adjustment of a piece of iron wire about double the diameter of a medium sized knitting-needle, bent to the curvature of the arch, and made fast to the inner edge of the plate, by being partially imbedded in it. The rim of wax is now arranged along the summit of the alveolar borders, and after being properly trimmed, it is taken from the model and put in the mouth. The upper plate and rim of wax is then adjusted, the bite of the mouth taken, and the antagonizing model made in the manner described for a full set of block-teeth to be mounted on gold.

Fig. 289.



In Fig. 290 is represented a double set of teeth arranged in wax upon an antagonizing model, the upper and lower ready to be placed upon their respective models for the formation of matrices.

Fig. 290.



For partial sets of teeth the Cheoplastic process is peculiarly applicable, the perfect accuracy of the adaptation of the base secures so firm an adhesion to the mouth as to render clasping to any of the remaining natural teeth almost always unnecessary. A single tooth or several teeth situated in different parts of the arch, can be replaced with the greatest ease, and they are so securely retained as to occasion no inconvenience or annoyance to the patient. The only precaution necessary to be observed in their construction, in addition to that of accuracy of adjustment and neatness of execution, is to thicken the projections of the wax plate between the remaining natural teeth sufficiently to prevent the liability to breakage of the metal at these points. These portions, when very narrow, should be made double the thickness of the other parts of the plate. After having adjusted

the artificial teeth, and made them fast to the wax plate, the teeth of the model should be cut off before making the other half of the matrix, as it would be almost impossible to separate the two halves without breaking the teeth and other important parts.

A piece from which one or more teeth have been broken can be easily repaired. If any portion of the tooth remain it is removed, and the metal that united it to the base filed away. A new tooth is selected and ground until it corresponds with the adjoining teeth. The floor of the groove filed in the base is covered with a piece of wax of the thickness of that used for the plate; the tooth is then put in place, wax applied on the outside of the upper edge, filling the groove in the plate; then applied on the inside, filling the hole or groove in the back of the tooth, designed for its attachment to the base. This is chiefly done with the wax knife (Fig. 282) made hot in the flame of a spirit lamp. The apex of a roll of wax about an inch and a half in length, of a conical shape, is united to the wax on the back part of the tooth: the apex should be little more than an eighth, and the base half an inch in diameter, which latter should be half an inch above the summits of the teeth. A small stem of wax is united to the wax on the outside of the tooth, with the free extremity half an inch above the tooth.

The sheet iron or tin ring such as was employed in making the model, is now filled about one-third full of plaster and spar mixture, and the piece put immediately in it with the base downward, pressing upon it sufficiently to imbed the concave surface. A thin mixture of the same composition is then poured on top, filling the ring and covering the summits of the teeth about a quarter of an inch. When hard, the ring is removed, and the projecting stems of wax withdrawn. The wax on each side of the tooth and between it and the base is melted out by throwing the flame of a spirit lamp with a blow-pipe into the gate behind the tooth and the vent in front.

The matrix thus formed is dried and made hot in a stove or furnace, as in the first instance. The alloy is then melted and poured into it through the gate behind the tooth, and if it comes up, filling the vent in front without bubbling, the piece will come from the matrix perfectly restored. When cold, the plaster and spar are broken from the teeth, and the metal around the new tooth finished in the same manner as previously described.

PART SEVENTH.

DISEASES AND DEFECTS OF THE PALATINE ORGANS.

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Although the treatment of the diseases of the palatine organs belong more properly to the province of general medicine than to the specialty of Dental Surgery; yet, inasmuch as the dentist is often called upon to remedy the defects that sometimes result from them, it is important that he should have, at least, some general knowledge of the morbid phenomena liable to be developed in these parts. But in treating of these diseases, it is not the intention of the author to enter into a minute description of their pathology or therapeutical indications. His principal object is to notice the defects resulting either from malformation or from the changes in structure to which they are apt to give rise, and to point out the means by which they are remedied.

The defects of the palatine organs may be divided into *accidental* and *congenital*. The first, as has been just intimated, are caused by pathological changes in structure. The second are the result of malformation or imperfect development of the parts. But from whatever cause they may be produced, their effect upon the voice, speech, mastication and deglutition are the same; these functions being all impaired by them, in proportion to the nature and extent of the change. When they extend so far as to cause a complete division of the hard and soft structures, distinct utterance is wholly destroyed, and the acts of mastication and deglutition are greatly impaired and always performed with difficulty.

When the loss of substance is the result of disease, and extends so far as to establish a communication between the mouth and nasal fossæ, the defect can seldom be remedied in any other way than by means of an artificial obturator. Even when the

defect is congenital, though the aid of surgery may very often be successfully invoked, the resources of art will, in the majority of cases, be required. When the defect is confined to the vault of the palate, and consists of a simple opening between the mouth and nasal cavities, these resources may always be successfully applied, and even when the loss of substance extends to the soft palate, and anterior part of the alveolar ridge, a mechanical appliance may be so constructed, as to restore, to some extent, the functions dependent upon the presence and integrity of the natural parts.

CHAPTER FIRST.

DISEASES OF THE PALATE.

In common with other parts of the body, the palate sometimes becomes the seat of various morbid phenomena; but the occurrence of disease here is generally the result of constitutional causes, such as certain depraved habits of body. It is, perhaps, more frequently induced by secondary syphilis than by any other cause; and when so, its ravages are often truly deplorable. It may, however, result from the immoderate and protracted use of mercurial medicine, or from a scorbutic, cancerous, scrofulous or rickety diathesis of the general system. Among the diseases liable to attack the palate, are tumors; caries and necrosis of the bones; ulceration of the mucous membrane; and inflammation, elongation and ulceration of the uvula. In consulting writers on the diseases of the palate, the author has been able to find but few who have written at much length on them: for the information which he has been able to obtain upon the subject, except that which he has derived from his own limited observations, he is principally indebted to Jourdain and Boyer. The first of these authors has devoted, in the first volume of his Treatise on the Surgical Diseases of the Mouth, about one hundred and forty pages to the affections under consideration.

TUMORS OF THE PALATE.

Tumors of the palate are less frequent in their occurrence than morbid growths from the gums and alveolar processes; they are as variable in their appearance and character as are those which are developed from other parts of the mouth. Sometimes they originate from the mucous membrane, at other times from the periosteal tissue; sometimes they are attached by a broad base, at other times by a very narrow one. Some have a smooth surface, a whitish and pale red color, and a firm

fleshy texture: these generally grow very slowly, and are seldom of a malignant character. Others have an uneven surface, are soft and vascular, of a purple color, and bleed from the slightest injury.

The last are of a more malignant nature, and frequently have a cancerous tendency; they are also more sensitive to the touch and more painful. The first are seldom attended with much pain, and are less dangerous. In forming a prognosis, therefore, it is necessary to distinguish between those which are simple, and those which are of a malignant or cancerous nature.

Tumors of the palate, as well as those of other parts of the mouth, are always productive of annoyance and inconvenience to the patient in proportion to their size and the malignancy of their character. They impede, and, sometimes, destroy the functions of mastication, and render those of speech and deglutition exceedingly difficult and imperfect.

A more minute description of tumors of the palate is deemed unnecessary, since that which has been given, in a preceding part of the work, of the morbid growths upon the gums and alveolar processes, will be found, for the most part, applicable to those of the palate. With regard to the peculiar pathological characteristics and nosological classification of the various kinds of tumor, to give such a description forms no part of the author's design. He could not do so without extending the limits of this part of his work to too great a length; therefore, the reader is referred, for more detailed information upon these subjects, to works on general medicine and surgery.

CAUSES.

Concerning the causes of tumors of the palate, as well as those of other parts of the body, there exists some diversity of opinion. Some authors believe that they are attributable in all cases to a peculiar or specific constitutional vice, as the venereal, scorbutic, cancerous, scrofulous, etc.; while others think they may occur in individuals in whom no such habit or vice exists. That the character of the tumor is determined by the habit of body, or constitutional tendency of the individual, is, we believe, a question which, at present, admits of little doubt, though some

exciting cause may be necessary to the commencement of the disease. Local irritation is perhaps the immediate or exciting cause of the various morbid growths of the palate; but this, unless favored by some specific or peculiar constitutional tendency or cachectic habit of body, would not be likely to give rise to them. Thus, while the former would seem to be the exciting cause, the specific character of the disease, as has been just stated, is evidently determined by the latter.

Every habit of body, or tendency to any particular form of diseased action, may be regarded as having a susceptibility to morbid impressions peculiar to itself. Hence, an irritant which, in one case, might not be productive of any appreciable disturbance, would, in another, give rise to a morbid growth of a more or less malignant character, according to the habit of body, or constitutional tendency of the individual.

The irritation produced by dead, loose and diseased teeth, ulcers of the mucous membrance and necrosed bone, are among the most common of the exciting causes. Some may, perhaps, be disposed to question the agency of dental irritation in the production of a morbid growth from the palate, but the fact is too well established to admit of doubt. Many well authenticated cases are on record, which conclusively prove that diseased teeth are capable of exerting a morbid influence upon these parts. M. GUYARD* reports the case of a woman, forty years of age, who had a cancerous excrescence of the palate, caused by an irritation produced by the superior incisors; and numerous examples of tumor and other diseases of the palate, resulting from the presence of diseased teeth, are given by Jourdain and other authors.†

But there are other causes, such, for example, as salivary calculus, mucous engorgement of the maxillary sinus, acrid saliva, and mechanical injuries from blows, or from hard substances taken into the mouth. Roche and Sanson, in their Theory and Practice of Medicine and Surgery, assert that from the irritation produced by syphilitic ulcers, carcinomatous tumors nearly always follow.‡

* Journal de Med., tome xix., p. 361.

† Traité des Maladies Chirurg. de la Bouche.

‡ Nouveaux Elements de Pathologie Medico-Chirurgicale, tome 4, p. 1011.

TREATMENT.

Although tumors of the palate may sometimes disappear spontaneously on the removal of the exciting cause, the proper curative indication consists in their complete extirpation. When they are attached by a small base, this may be easily effected with a pair of scissors having properly curved blades, or by means of a ligature, in the manner directed for the removal of similar tumors upon the gums. But when they are attached by a broad base, a curved bistoury is the most convenient instrument that can be employed; it will be found convenient to have two, a right and a left, so as to be able to cut upon either side of the tumor.

Boyer describes an operation which he performed for the removal of a hard, white, indolent tumor, of the size of a large nut, situated a little behind the middle of the palate, and which had occasioned the patient no other inconvenience than an unpleasant sensation during mastication and deglutition. He excised the tumor with a bistoury, curved so as to fit exactly the vault of the palate, which he had made for the purpose. After having removed the tumor, he destroyed the membrane from which it had originated with a rasp. The hemorrhage was suppressed with vinegar and water and pledgets of lint. The wound soon healed, and at the expiration of eight years there were no signs of a reproduction of the disease.*

In the removal of tumors from the palate, as well as from other parts of the body, no portion should be left; as, in this event, a reproduction of the disease would be likely to occur, more especially if it be of a malignant character. The operation should be performed, too, before the tumor has acquired great size, or has implicated, to any considerable extent, the neighboring structures in the diseased action.

When the morbid production is of a cancerous nature, however perfectly it may be removed, there is always great danger of its reproduction; to guard against this, as far as possible, the application of the actual cautery is recommended by many sur-

* Traité des Maladies Chirurg., tome 6, p. 449.

geons, not only for the purpose of causing exfoliation of a portion of the bone, but also to arrest the hemorrhage which generally attends this class of operations. Boyer, who says he has performed the operation for the removal of tumors from the palate several times, frankly admits that he has never been successful where they were of a malignant character. But, notwithstanding the great liability to reproduction of most morbid growths, this does not always happen, as is well attested by many cases on record; from which it may be well to cite three or four.

Pierre Guyard reports in the Journal, to which reference has before been made, the case of a woman, forty years of age, who had a cancerous excrescence of the palate, of many years' standing, which weighed nine ounces. This excrescence was extirpated, and the patient restored to health.

The case of a man, forty years of age, affected with so large a tumor of the palate that he could take no nourishment, except in a fluid state, is reported by VARNER. In this case, it was of a cartilaginous character, interspersed with osseous points, and the operation for its removal was also successful.*

Jourdain describes the case of a man, who from the irritation produced by the roots of several decayed teeth, had a swelling of the upper lip and nose, and a tumor of the palate as large as a pigeon's egg. A fistula, traversing the alveolar border, extended from the superior lateral incisor to the first molar of the same side, from which a large quantity of matter was discharged. The teeth, being troublesome, were removed. The discharge of matter soon ceased. He next removed the tumor from the palate, which exposed a portion of necrosed bone; this exfoliated in a few days, leaving an opening into the nose of the size of a large quill, through which fluids, taken into the mouth, readily passed. By the application of caustics, the sides of the opening were caused to granulate, and in six weeks it had entirely healed.

The same author mentions the case of a lady, who had a tumor of the palate caused by erysipelas. The last named disease having extended to the lips, nose and vault of the palate, caused in the last mentioned place ulceration, from the centre of which

* Vide Traité des Maladies Chirurg. de la Bouche, t. I, p. 427.

grew a small fungous tumor. This was removed, and a portion of the bone, which was exposed, was found to be in a necrosed and partially exfoliated condition. This was extracted with an excavator, and, under proper treatment, the patient soon recovered.

In presenting the foregoing cases, the author has not thought it necessary to give anything more than the important facts connected with each. A full translation of the reports would occupy more space than he wishes to devote to this particular subject.

It is seldom that the operation for the removal of tumors of the palate, are followed by results as favorable as those furnished by the foregoing cases. If it were necessary, many examples of tumors of the palate, attended with fatal effects. might be cited. Jourdain mentions one given by M. PLATER, of a cancerous tumor of the palate, caused by ulceration of the throat and uvula.

Both before and after the operation, such general or constitutional treatment as may be indicated by the habit of body or vice under which the patient may be laboring, should be adopted. If of a scorbutic or scrofulous habit, or affected with a syphilitic disease, suitable remedies should be prescribed, and when practicable, such local irritants as may have acted as exciting causes should be removed.

CARIES AND NECROSIS OF THE BONES OF THE PALATE, AND ULCERATION OF THE MUCOUS MEMBRANE.

The bones of the palate sometimes become the seat of caries and necrosis, causing ulceration of the subjacent soft parts, and the destruction of a greater or less portion of the structures which separate the cavities of the mouth and nose. Although these effects are of more frequent occurrence than tumors, they are less dangerous in their consequences. Commencing with inflammation and suppuration of the periosteal tissue, caries, and necrosis of the bones, accompanied by ulceration of the investing mucous membrane, supervene, and ultimately exfoliation takes place, when an opening of greater or less size, between the buccal and nasal cavities, is established.

During the progress of the disease, fetid sanies is continually discharged from one or more fistulous openings, into the mouth, and sometimes into the cavities of the nose, rendering the condition of the unhappy sufferer exceedingly loathsome and distressing. The progress of the disease is often slow, continuing, not unfrequently, for weeks, months, and in some cases even years, destroying all the pleasures of life, and rendering existence itself a burden. A case of this kind was recently introduced into the infirmary of the Baltimore College of Dental Surgery, which will be noticed at some length, when the author comes to treat of the means employed for remedying defects of the palatine organs.

Dr. Brown, of Missouri, describes a very interesting case of the destruction of a large portion of the palate plates of the superior maxillary and palate bones, accompanied by the loss of the left lateral and central incisors.*

The ravages of caries and ulceration of the palate are sometimes so great that the palatine bones, the palate plates of the superior maxilla, the vomer, turbinated and nasal bones, together with the velum and uvula, are entirely destroyed, but when thus extensive, they are seldom arrested, except with the life of the patient.

The ulcerative process of the soft parts, when resulting from caries of the bones, frequently extends to the pituitary membrane, lining the floor of the nasal fossæ. A case of this kind, and to which the author will hereafter have occasion to refer, is related by Jourdain.

But ulceration of the mucous membrane, lining the vault of the palate, often occurs while the bones are in a healthy condition. It is frequently caused by inflammation and ulceration of the velum and uvula, whether resulting as an effect of secondary syphilis or from malignant ozena produced by other causes. But, whatever the producing cause of the ulceration, it may ultimately give rise to caries and necrosis of the bones.

* Vide Am. Jour. Dent. Sci. vol. 6, p. 236.

CAUSES.

Caries, necrosis and ulceration of the palate, as in the case of tumors, result from local irritation and certain habits of body, or constitutional vices. The immediate or exciting cause is local irritation; but the extent of the effects resulting from such irritation is, as we have before stated, in proportion to the susceptibility of the body to morbid impressions. The local irritations are the same as those which have been already mentioned, namely: dead and loose teeth, roots of teeth, salivary calculus, mechanical injuries, acrid humors, etc. The case of a lady of irreproachable character is related by Jourdain, in whom a scratch on the palate with a fish-bone caused a tumor, which suppurated and degenerated into an ulcer, with hard, elevated edges and a fungus in the middle.* A case, in which similar effects were produced, and by the same cause, was mentioned to the author, in 1849, by a dentist of Baltimore. Local irritation, unquestionably, has much more to do in the production of the diseases under consideration than many seem to imagine or are willing to admit. Most writers are of the opinion that they are wholly caused by some constitutional vice, and nearly always by the venereal; but that this opinion, to some extent at least, is erroneous, will be fully proven by certain facts which will be presented when we come to speak of the treatment of these affections.

TREATMENT.

In the treatment of caries of the bones of the palate, it is important to ascertain if the patient be laboring under any constitutional vice which may have contributed to the disease; also, what were the local irritants concerned in giving rise to it. If the inflammation from which it resulted was caused by mechanical irritation, the irritants should at once be removed. If decayed, dead or loose teeth be suspected as having had any agency in its production, they should be immediately extracted; but so long as any portion of decayed or necrosed bone remains,

* Traité des Malad. Chirurg. de la Bouche, tom. 1, p. 407.

it is needless to say, the ulcerations or fistulous openings in the soft parts cannot be healed. These, as soon as they have become sufficiently exfoliated, should be detached and removed; in doing which it may be necessary to increase the size of the external opening. During the process of exfoliation, the mouth should be frequently gargled with astringent and detergent lotions, for the purpose of neutralizing the odor of the offensive matter which is continually discharged.

Suitable constitutional remedies should, at the same time, be prescribed. As in the case of tumors, if the patient be laboring under a scorbutic, scrofulous or venereal diathesis, the indications for the cure of these should be properly fulfilled. But, before instituting any general treatment, we should be well assured that our diagnosis is correct. A venereal vice is sometimes suspected when none exists, as is shown by the following brief summary of the history of a case related by Jourdain:

The subject of this case was a man who had a swelling which occupied the whole of the left side of the vault of the palate, from which there had been a fistulous opening for a long time. The edges were hard and indurated. Venereal vice was suspected as the cause, and for this disease treatment was proposed: but, the patient not being willing to submit, Jourdain was consulted, who advised the removal of the roots of three or four teeth in the vicinity of the disease. This operation was performed, and the fistulous opening at the same time enlarged, when the bone was found to be in a carious condition; but with little other treatment, a complete cure was soon effected.

That the effects resulting from dental irritation may extend to the palate, is shown by the following particulars, taken from the history of a case given by the same author: A man called upon Jourdain for advice in relation to a tumor on the vault of the palate. Upon examination, a sensible fluctuation was perceived. On being pressed, fetid pus escaped from a small fistulous opening between the right lateral incisor and canine tooth, and also from the socket of the second bicuspid, which had been extracted a short time before. The alveolar socket of this tooth communicated with the first-mentioned fistula and the disease in the palate. Notwithstanding these two outlets for the escape of the matter, it accumulated in the palatine tumor. Various means

were resorted to for the cure of the disease, but without success. The nasal fossæ, by the accumulation of matter, were partially closed, the alveoli of the lateral incisor, cuspid and first bicuspid became necrosed, the teeth loosened and were extracted. The alveoli exfoliated, the tumor of the palate was opened, when the bones of the palate and alveolar ridge were found in a necrosed and partially exfoliated state. These were removed without much difficulty, leaving an opening through to the pituitary membrane which lined the floor of the nasal fossæ. These portions of bone having been removed, the parts soon healed.

That the caries in the two last cases was caused by dental irritation, there can be no question, and that it often results from this cause, we have not the least doubt. In the last case, it is probable that the second bicuspid of the affected side was not extracted until an abscess had formed at the extremity of its root. The matter, instead of escaping externally, had effected a passage through the inner wall of the alveolus, and thence between the palate plate of the superior maxilla and mucous membrane to near the median line, where it had accumulated, produced the tumor mentioned by Jourdain, and ultimately made a passage for its escape between the lateral incisor and cuspid. Several cases, followed by very similar effects, have fallen under the immediate observation of the author. But when associated with a cachectic habit of body or venereal vice, the effects are more destructive, and, in this case, local treatment will not suffice.

Ulceration of the palatine mucous membrane may occur without caries of the subjacent bone; it may result as a consequence of ulceration or other disease of the velum or uvula, or from some mechanical injury inflicted upon the parts. When it is of a simple nature, cooling and astringent gargles, preceded by mild aperients, will generally suffice for its cure. If dependent upon a specific constitutional tendency or vice, appropriate general remedies should be employed. But with regard to the treatment of ulcers of the palate, we shall have occasion to speak when we come to treat of the diseases of the velum and uvula.

INFLAMMATION AND ULCERATION OF THE VELUM AND UVULA.

The velum palati and uvula sometimes become the seat of inflammation, accompanied by pain, increased redness, difficulty of deglutition and articulation. Most frequently it terminates in resolution, sometimes in ulceration, and at other times in gangrene. When resolution is the termination, it gradually subsides, after having continued for a greater or less length of time; when by ulceration, one or more white or ash colored spots appear upon the velum and uvula, after it has continued for a certain period; and when by gangrene, the part, after having assumed a dark purple or almost black color, sloughs. Fortunately, this latter termination rarely happens.

As a consequence of inflammation, the uvula sometimes becomes tumefied and elongated; at other times it becomes elongated when there is no apparent tumefaction. In the latter case, it is familiarly termed a "falling of the palate." Most frequently, when it is elongated, its thickness is at the same time increased. In this case there is an increase of redness; but when there is elongation, without an increase of size, resulting simply from relaxation of the part, its color, instead of being heightened, is often diminished, presenting a whitish or semi-transparent appearance. This description of elongation is termed serous tumefaction of the uvula. It is seldom accompanied by pain.

When the uvula becomes so much elongated as to rest upon the tongue, it causes irritation, difficult deglutition, attended often by a sense of suffocation, the frequent expulsion of mucus from the throat, and sometimes a disagreeable cough.

Ulcers of various kinds sometimes attack these parts, though they are less subject to them than are the other parts of the mouth, fauces and tonsils. Sometimes the ulcers are of a simple nature, at other times they are aphthous, scrofulous, scorbutic, venereal or cancerous, according to the specific poison or diathesis which has given rise to them. When the ulcer is not dependent upon constitutional causes, it is termed a simple ulcer, and is nothing more than a granulating sore which secretes healthy purulent matter.

Aphthous ulcers at first appear in the form of whitish or transparent vesicles, which break, and are ultimately transformed into ulcers, either surrounded by a slightly elevated edge of a reddish color, or spread and unite with each other. The former are termed *discrete*, and the latter *confluent*, aphthæ. But ulcers of this kind generally appear in other parts of the mouth and fauces before they attack the velum and uvula of the palate.

The velum and uvula are, perhaps, more subject to venereal, than to any other kind of ulcers. The symptoms of these are, sometimes, very similar to ulcers which result from some other specific constitutional vice, and their character can only be positively determined by ascertaining all the other circumstances connected with the history of the case. They are generally preceded by ulceration of the throat, dull heavy pain, especially at night, increased redness of the parts, swelling of the uvula, and difficult deglutition. The parts usually have a whitish, dirty gray, or ash-colored appearance, with slightly elevated and irregular margins, and secrete thin ichorous matter of a very fetid odor. The surrounding parts are preternaturally red, and sometimes present an almost purple appearance. At other times the ulcers appear in the form of aphthous spots, followed by sloughing of the surrounding parts. Sometimes the ulcers attack the posterior side of the velum and uvula first, where they commit extensive ravages before they appear anteriorly. From these parts they often extend to the vault of the palate, but more frequently, when they appear here, the periosteal tissue and bones are diseased before ulceration shows itself in the mucous membrane.

The velum and uvula are sometimes the seat of bad conditioned ulcers, such as the cancerous, scrofulous, etc. Sometimes they arise as a consequence of protracted and immoderate use of mercury. When they result from this cause, they are preceded by a copperish taste in the mouth; increased flow and viscidity of the saliva; tumefaction and increased sensibility of the gums, looseness of the teeth; a peculiar, disagreeable odor of the breath, general debility and emaciation, and sometimes diarrhœa. Ulceration attacks the gums, edges of the tongue, the mucous membrane about the angles of the jaws, the inner surface of the cheeks and throat, before it does the velum and uvula.

CAUSES.

Inflammation of the velum and uvula most frequently result from irregular exposure to cold and moisture, though it may sometimes be produced by some local irritation, as mechanical injury, acidity of the gastric and buccal fluids. Ulceration of the parts may result from the same causes, the character which the ulcer assumes being determined by the habit of body, or peculiar diathesis of the general system. Elongation of the uvula is caused either by inflammation and general enlargement, by relaxation of the parts, or by serous infiltration of its apex.

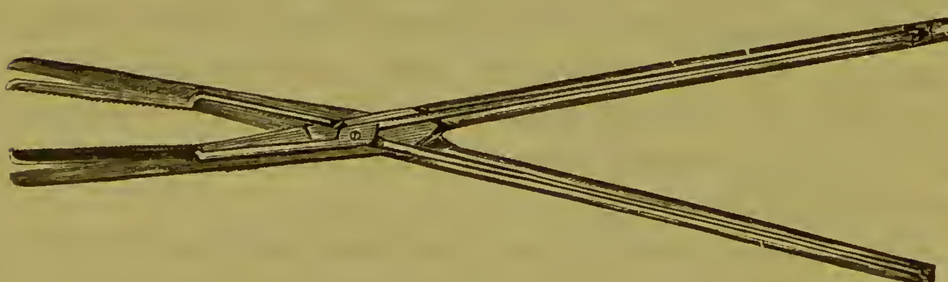
TREATMENT.

For simple inflammation of the velum and uvula, unaccompanied by fever or other general constitutional effects, little else will be required than gargling the throat with an infusion of capsicum, sweetened with honey. When the inflammation is severe, and the vessels have the appearance of being distended, advantage may be derived from scarifying the parts.

But when the uvula is so much elongated as to rest upon the tongue, and cause a sensation of suffocation or a troublesome cough, if it does not yield to exciting and astringent gargles, it may become advisable to remove a portion of it.

For this operation, though an exceedingly simple one, a variety of instruments have been invented. The best, however, which the author has seen, is the one invented by Dr. Hullihen.

Fig. 291.



This instrument, although very simple in its construction, is an exceedingly useful one, for, at the same time that it cuts the uvula, it secures the excised extremity, and prevents it from falling. The construction of this instrument, and the manner

of using it are so very simple, that the accompanying engraving will supersede the necessity of any description.*

For a simple ulcer of the velum or uvula, no other treatment will be required than to gargle the throat occasionally with some gently stimulating and astringent lotion; the one recommended for inflammation of these parts may generally be employed with advantage.

In the treatment of venereal or syphilitic ulcers of the velum and uvula, little advantage will be obtained from local remedies. They can only be cured by appropriate constitutional treatment, such as is prescribed in works on general medicine and surgery. To these, therefore, the reader is referred for information upon this subject.

In cases of mercurial ulcers, it is desirable that two or three liquid evacuations from the bowels should be procured daily. For this purpose, sulphate of magnesia or sulphur may be administered night and morning. The mouth should, at the same time, be gargled six or eight times a day with some gently astringent lotion. A weak solution of the sulphate of zinc, or alum sweetened with honey, may sometimes be advantageously employed, but more benefit, perhaps, will be derived from the use of the chlorinated solution of soda. When the pain is so severe as to prevent rest, opium should be prescribed. The diet of the patient, for the most part, should consist of farinaceous substances, and after the ulcers have begun to heal, milk, light soups, etc., may be recommended.

In the treatment of scirrhous and other ill-conditioned ulcers of the velum and uvula, dependent upon a cachectic habit of body, it is necessary that the constitutional indications should be properly fulfilled, and that the vitiated action of the disease should be changed by the application of local irritants, such as caustics. The application of the actual cautery has been found more efficient in changing the condition of ulcers of this sort, and exciting a healthy action in them, than any other means which have been employed.

For cancerous ulcers, it has been found necessary to remove a greater or less portion of the velum and uvula, and even this operation has seldom proved successful; for the disease, after a greater or less length of time, reappears in situ or in some of the neighboring parts.

* An engraving and description of Dr. Hullihen's uvula scissors are contained in vol. 7, No. 3, of Am. Jour. and Lib. of Dental Science.

CHAPTER SECOND.

DEFECTS OF THE PALATINE ORGANS.

The nature and extent of the defects of the palatine organs are various. They sometimes consist of a simple perforation of the vault of the palate; this may be in the centre, or on either side of the median line. At other times, the loss of substance extends to the entire vault and velum. Nor is the loss always confined to these parts; it sometimes extends to the anterior part of the alveolar border, and a portion of the upper lip, constituting what is usually termed hare-lip.

The defects of the palatine organs, as we have before stated, may be divided into accidental and congenital. The first resulting from accidental causes, the second from malformation of the parts.

ACCIDENTAL DEFECTS.

Accidental lesions of the palatine organs are divided by M. Delabarre into three species. The first consists in perforations of the vault of the palate; the second, in perforations of the velum, and the third, in the destruction of the entire vault of the palate, or of a great portion of it. To this last might also be added the destruction of the whole, or a large portion of the velum, as well as of the vomer, part of the alveolar border and turbinated bones.*

It has also been remarked, that lesions of the palate and velum, resulting from disease, differ from congenital defects. The first most frequently perforate the side of the palatine vault, and communicate with only one nostril; whereas, the latter, as will presently be seen, occupy the centre of the arch, and penetrate both of the nasal cavities.

The causes of accidental lesions or defects of the palate and velum, have already been treated of; the manner of remedying them will hereafter be described.

* Traité de l'Art Méchanique du Chirurgien Dentiste, t. 1, p. 294.

CONGENITAL DEFECTS.

Congenital defects of the palate occupy the median line or palatine raphe, and consist in the division to a greater or less extent of the osseous and soft textures. This division is sometimes confined to the vault of the palate; at other times the velum, the anterior part of the alveolar arch and the upper lip participate. It forms a communication with both nostrils; and when the malformation extends to the alveolar border and upper lip, which is divided vertically in one, and sometimes in two places, it gives to the mouth a most disagreeable aspect. But hare-lip is sometimes met with when there is no imperfection of the osseous structures; and imperfections are often met with in these latter when the lip is perfect. In some cases the cleft or fissure is more than three-fourths of an inch wide throughout the whole extent of the palate and velum, accompanied by absence of the whole of that portion of the alveolar border which should be occupied by the four incisors; at other times the alveolar arch is divided in two places, leaving a portion between the lateral and central incisors, or one lateral and one central, which project more or less, and thus very greatly increase the deformity. Although a double hare-lip, with two divisions of the alveolar border, is seldom met with without some defect of the palatine organs, such cases do occasionally occur. Dr. Marion Simms, a skillful and distinguished surgeon, formerly of Montgomery, Ala., describes a most interesting case of this kind, in vol. 5th, page 51, of the American Journal of Dental Science.

Congenital defects of the palate are sometimes accompanied by more or less deformity of the sides of the alveolar arch, and of the teeth. Sometimes the sides of the alveolar ridge are forced too far apart, and at other times they are too near each other, while the teeth are either too large or too small, with imperfectly developed roots, and generally of a soft texture.

Want of coaptation, resulting from defect of formation in the palatine plates of the maxillary and palate bones, are the cause of congenital deficiencies of the parts in question. In the human embryo of about the third week, the development of the *face* is

clearly in progress. Five tubercles bud out from the front of the cephalic mass, of which the middle one which is double, is directed vertically downward, and bears the appellation, *incisive* tubercles, because the intermaxillary bones, destined to bear the superior incisor teeth exclusively, are developed in it. On either side is the tubercle or rudiment of an upper maxillary bone, which is separated from its fellow by a wide interval, and from the neighboring incisive process by a fissure. The fourth and fifth tubercles, also separated in front, form by their subsequent union in the median line the inferior maxillary bone. At the same period the palate begins to be formed by the approach toward the median line of two horizontal plates or processes, springing from the maxillary process on either side.

If now, development proceed regularly and normally, the palate processes of the superior maxilla meet in the median line and unite with the blended intermaxillary tubercles, while the vomer grows downward to meet the palate processes in their line of union. The upper jaw, after the accomplishment of the changes, is complete, and the formation of the lip and primary dental groove follow in due course. But it sometimes happens that the superior maxillary and intermaxillary processes fail to unite with each other, whence we have the malformation known as *hare-lip*, or the palate plates are arrested in their growth, and permanent *fissure of the palate* is the result. Consequently, the fissure of single hare-lip is never exactly in the median line, but on one edge of the intermaxillary bone; whereas, in double hare-lip, a fissure exists on each side of this bone, into which the four incisor teeth are implanted.

Fig. 292.

Fissure of the palate is usually a little lateral and not median, as it results from a deficiency of one or other of the palate plates of the upper maxillary bone; and it is frequently associated with hare-lip and fissure of the upper jaw.

The tubercles, or formative processes of the lower jaw, advance and meet in the median line, while the upper maxillary processes are still separate. In man they are consolidated into a

single piece; but they remain permanently divided in many of the lower animals by a median suture.*

Thus it is seen, that the defects of the palatine organs which result from malformation, present as much diversity of character as do those which are produced by disease, or other accidental causes. Mr. Stearns, of London, in a very able and highly interesting paper, published in the London Lancet, on "Congenital Fissure of the Palate," in noticing their various anatomical peculiarities divides them into three classes.

The first class embraces all the cases in which the fissure extends through the velum, palate and maxillary bones, to the alveolar border and, sometimes, through the whole extent of the median symphysis. This form of fissure is the most extensive, and justly regarded as the worst, and is usually complicated with hare-lip.

In the second class, the bones of the palate are apparently entire, though the concavity of the arch may be somewhat greater than usual, and the fissure may extend a short distance into their "posterior margin." The lesion, in this case, is almost wholly confined to the velum palati.

The third class embraces those cases in which the fissure is confined to the soft parts, extending, perhaps, only a short distance up into the uvula. This form of fissure is, probably, less frequently met with than either of the preceding.

FUNCTIONAL DISTURBANCES, RESULTING FROM DEFECTS OF THE PALATINE ORGANS.

The principal effects resulting from an absence of a portion of the palatine organs, are, as we have before stated, an impairment of the functions of mastication, deglutition and speech. Distinct utterance is sometimes wholly destroyed, and mastication and deglutition are often so much embarrassed as to be performed only with great difficulty. These effects are always in proportion to the extent of the separation or deficiency of the parts. We shall first speak of those modifications of the functions of mastication and deglutition which result from absence of a portion of the palatine organs.

* Vide Dalton's Physiology.

The simple act of triturating the food may not be materially impaired by the absence of a portion, however extensive, of the palatine organs, unless the natural relations of the teeth of the upper and lower jaws are changed; still the process is more or less interfered with, as substances taken into the mouth cannot be so readily managed, as when the parts are in their natural state. They are constantly escaping from the control of the tongue, and passing up into the cavity of the nose.

In cases of congenital defects of the palate and velum, it is difficult to conceive how, in infancy, infants manage to obtain from the breast of the mother or nurse, the food necessary for their subsistence; yet, even when the anterior part of the alveolar border, and a part of the upper lip are wanting, the suggestions of natural instinct enable them by a peculiar management of tongue and lips to do it. The expedient resorted to for effecting this process is curious. The nipple, instead of being seized between the tongue, upper lip and gum, is taken between its lower surface, and the under lip and gum, and in this way it manages to extract the nourishment necessary for subsistence and growth. The tongue, as is remarked by M. Delabarre, is thus made to close the opening in the palate, and perform the office of an obturator. By contracting the lip and depressing the tongue, the milk is drawn from the breast of the mother or nurse. At this young and tender age, the child is not conscious of the imperfection of its palate; it is not, as is remarked by the author just mentioned, until the period arrives when it should begin to make its wants known by words, that it feels the importance of the functions of speech and begins to realize the misfortune with which it is afflicted.

"But as the child arrives at this period," says M. Delabarre, "the mechanism of sucking is perfected, and ultimately applied to the mastication of solid aliments. The food, when chewed, is conveyed between the tongue and movable floor, which serves for a point d'appui, and thence it is brought back between the teeth. Thus it is, that the complicated operation of mastication and deglutition is performed without the alimentary morsel getting into the nose; or, if this does sometimes happen, it is the result of accident. But in cases of accidental lesion of the palate, the individual has not the advantage of this training of the parts

during early infancy. Those who are afflicted with accidental lesions, no matter what may be their position and extent, having acquired the habit of eating, by placing the aliment upon and not under the tongue, can take no nourishment, without a part of it getting into the nose." When to this inconvenience is added a change in the natural relation of the teeth of the two jaws, mastication is rendered still more difficult and embarrassing. When this is the case, the tubercles of the teeth of one jaw, instead of being received into the depressions of those of the other, strike upon their protuberances, and cannot be made to triturate the food in as thorough and perfect a manner as is required for healthy and easy digestion. Thus, not only is the process of mastication rendered imperfect, but it is also more tedious.

The process of deglutition itself, so long as the velum and uvula are perfect, is not materially affected by a perforation simply of the vault of the palate, although much difficulty may be experienced in conveying alimentary and fluid substances to the fauces and pharynx. But when this curtain is cleft, or is partially or wholly wanting, deglutition is rendered very difficult, for, by the contraction of the muscles of the pharynx, part of the food is forced up into the nose. The reason of this will appear obvious, when we take into consideration the form and function of this movable appendage. When its muscles are relaxed, it forms a slightly concave curtain; but in the act of deglutition, the muscles contract, raise the velum and close the opening from the pharynx into the posterior nares. Thus alimentary substances and fluids are prevented from escaping into the nose.

It matters not, therefore, whether the imperfection of the velum palati be the result of accident or disease, its effects upon deglutition are the same. In proportion as the lesion or deficiency is great, will this operation be rendered difficult and embarrassing. M. Delabarre mentions the case of an individual, who, in consequence of an imperfection of the palate, could swallow no fluids without a part being returned by the nose. To obviate this inconvenience, he had to throw his head sufficiently far back to precipitate them into the œsophagus. This is an expedient to which others, thus affected, have been compelled to resort.

Imperfection of speech always results from an opening in the palate, for this gives to the voice a nasal twang, and renders the formation of some sounds impossible. The loss of the teeth, though never to the same extent, is productive of the same effect. To comprehend fully the manner in which a lesion of the palate may affect the utterance of speech, it will be necessary to understand the agency which the several parts of the mouth have in the formation of articulate sounds. Speech consists in the sounds produced by the organs of the glottis modified by the organs of the mouth. The modulation of the voice, that is, the raising or lowering of its pitch, is accomplished by the vocal cords of the glottis: but the articulation of the consonants requires the co-operation of all the movable and fixed parts of the mouth—pharynx, palate, tongue and lips, teeth and palatine arch. Hence, if any of these be defective or wanting, the power of forming some of these sounds is wholly lost, of others very much impaired; hence also the ability to sing is much less interfered with than the power of distinct speech. The tongue has a remarkable power of adapting itself to the loss of teeth and of some other parts, so as measurably to correct the effect on speech; but the effect of the loss of the hard or soft palate upon the voice cannot be remedied in any such way.

CHAPTER THIRD.

MANNER OF REMEDYING DEFECTS OF THE PALATINE ORGANS.

Defects of the palatine organs are sometimes remedied by means of a surgical operation, termed *staphyloraphy;* but more frequently, by supplying the deficiency of the natural parts with a mechanical substitute. The operation of staphyloraphy, when it can be successfully performed, is the best and most perfect method that can be adopted for remedying imperfection of the parts in question. The application of a mechanical substitute, however, though it may not completely restore the functions dependent upon the integrity of the natural parts, will often so improve them, as to render the inconveniences resulting from such imperfection, scarcely perceptible.

In treating upon these methods, we shall first describe the operation of staphyloraphy, and, afterwards, the various mechanical appliances employed for the purpose, which are designated by the names of *obturators* and *artificial palates.*

STAPHYLORAPHY.

It rarely happens, except in cases of congenital fissure, that the operation of staphyloraphy can be successfully performed, and only then, when the edges of the cleft velum are firm and can be easily brought together. There are many ways in which the success of the operation, even in cases apparently the most favorable, may be defeated. For example, the ligatures may be detached by attempting to swallow, or clear the throat; or by coughing or sneezing; or by inflammation and sloughing of the parts. Unless these are carefully guarded against, the best efforts of the surgeon may be frustrated.

The idea of this operation was first conceived by an ingenious French dentist, by the name of Le Monnier, who attempted, and with success, to perform it as early as the year 1764. But

for more than half a century afterward, it does not seem to have attracted any attention, or to have been generally known to the medical profession. In 1819, however, M. Roux, a celebrated French surgeon, and author of an able memoir upon the subject published in 1825, performed the operation upon Dr. Stephens, a young American physician.* In 1820, it was performed for the first time in the United States, by Dr. J. C. Warren, of Boston, and in 1822 in England, by Mr. Alcock.† Now, it is classed among the regular operations of surgery.

As the success of the operation depends in great degree upon the consent of the patient, he should, as a general rule, have attained a sufficient age to enable him to appreciate its importance, before it is performed. The late Dr. Hullihen, of Wheeling, Va., however, stated that he had once performed the operation with success on a child nine years of age, but the author thinks that it is generally better to defer it until after the fifteenth or sixteenth year; and the natural excitability of the parts should previously be as much lessened as possible, by frequently touching and moving them about with the finger. This should be done several times a day, for at least two weeks before the operation is attempted, and during this time, the patient should be restricted to a spare diet.

The earlier operations of staphyloraphy, or velo-synthesis, consist in removing the margins of the divided velum with a pair of curved scissors, as recommended by M. Roux, or a double-edged knife, and holding the raw edges in contact with each other until a union takes place.

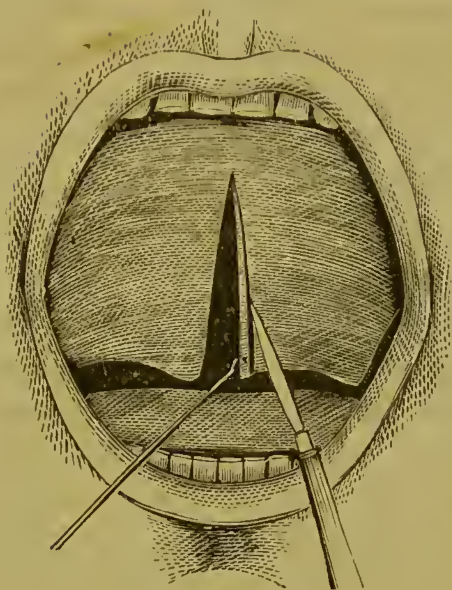
A number of ingeniously contrived instruments have been invented for the performance of the operation; but those really necessary are a sharp hook, a double-edged knife, short curved needles, a needle-holder (*porte-aiguille*), strong waxed ligatures, and a pair of long-handled curved forceps, and scissors; other instruments may, in some cases, be required. In addition to the above, water, towels, and one or more assistants, will be needed.

* We are informed by Velpeau, in his Elements of Operative Surgery, p. 428, that M. Colombe performed the operation on a dead subject in 1813, and in 1815 endeavored to prevail on a patient to permit him to repeat it, but without success. In 1817, too, M. Graefe published in Hufeland's Journal some details concerning it, but the subject elicited no interest until M. Roux performed the operation in 1819.

† Dr. Reese's Appendix to Cooper's Surgical Dictionary.

Thus prepared, the patient, after having been previously subjected to the necessary preparatory treatment, should be placed in a chair facing a good light, with his head firmly supported by an assistant, and his mouth open. The operation may be commenced by inserting the hook into the margin of the velum, near its most dependent part, on the left side of the fissure, in the manner represented in Fig. 293. This instrument, held by an assistant, should be depressed so as to make the margin slightly tense. The point of the double-edged knife may now be placed below the most dependent part of the velum, a little to the left of where the hook is inserted (Fig. 293), and carried from below upward until it has reached the angle of the fissure, removing a strip from the margin about one line in width. This operation may be repeated in the same way on the opposite side of the fissure. Or the first part of the operation may be continued, in the manner described by Dr. Mütter; changing the knife from the right to the left hand, and directing the assistant holding the hook to pass his hand across and a little above the face of the patient, so as to keep up a constant traction upon the strip of mucous membrane removed by the first cut. The right margin of the fissure being then made tense, the knife is carried from above downward; thus completing, by a single incision, the whole of this part of the operation.

Fig. 293.



Further procedure should be suspended until the hemorrhage, seldom very great, shall have partially subsided. A needle, armed with a well waxed ligature, and held in a pair of suitable forceps (porte-aiguille) should be passed from before backward through the most dependent part of the left margin, about three lines from the edge. As soon as it is seen on the opposite side, it should be grasped by the assistant with a pair of longhandled

forceps, and drawn through: then seized again by the porte-aiguille, and passed, from behind forward, through the right margin of the velum directly opposite to the ligature in the left.

Fig. 294.

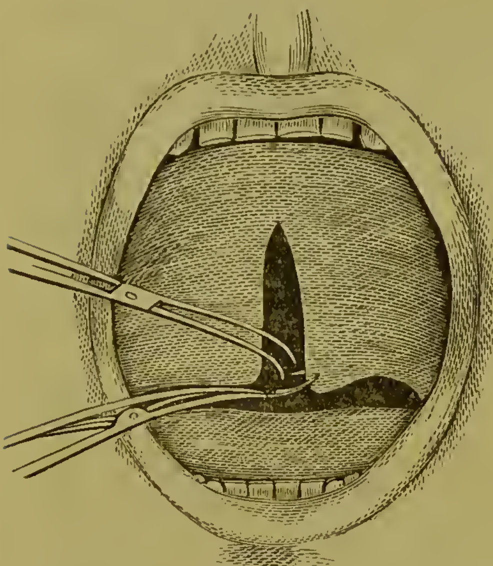
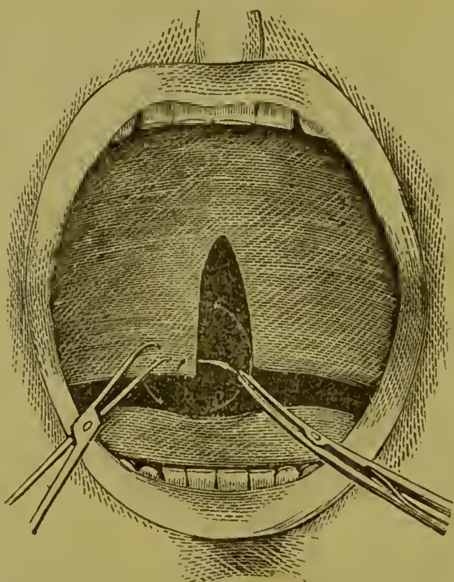


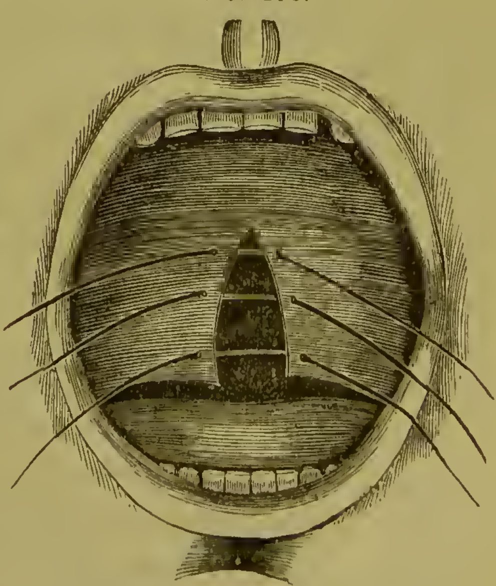
Fig. 295.



(Figs. 294, 295.) After the patient has rested a few minutes, a second, third, and, when necessary, a fourth ligature should be introduced. The passage of the needle through the left margin of the velum, from before backward, is represented in Fig. 294, and in Fig. 295, through the right margin, from behind forward.

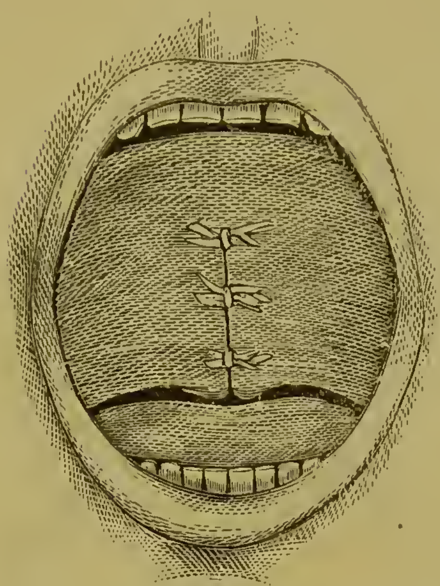
The ligature first introduced should now be tied, bringing the edges of the velum close together, and, afterward, the second and third, cutting off the ends of each. After the first knot of the ligature is tied, some precaution should be used to prevent this from slipping, while the second is tied. The method adopted by M. Roux for knotting the ligature is, to make the first fold of the knot with the fore-fingers of each hand placed back to back, and after this has been drawn suffici-

Fig. 296.



ently tight, it is seized by an assistant with a pair of forceps, and held until the second and last turn of the knot is made. In Fig. 296, three ligatures are shown in place, preparatory to being tied, which last process is seen completed in Fig. 297.

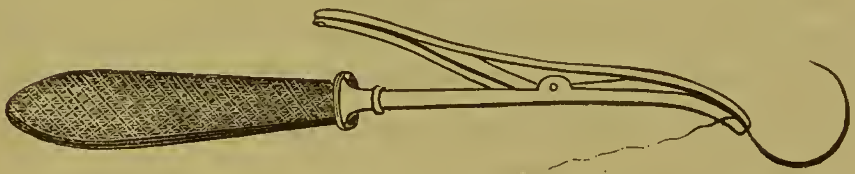
Fig. 297.



Some surgeons use two needles for each ligature, instead of one, as in the method just described—one at each end, and introduce them from behind forward, one through each margin of the divided velum.

The following cut, Fig. 298, copied from Liston's and Mütter's Surgery, represents the needle-holder, or "porte," of Schwerdt, which is, perhaps, as well adapted to the purpose as any instrument that can be employed. Dr. Physic's forceps

Fig. 298.



have also been used, but Dr. Mütter thinks this is a preferable instrument.

The late Dr. Hullihen, who performed the operation several times, invented a very ingenious needle-holder, which, we have no doubt, will ultimately supersede the use of most others. A description of the instrument, together with his method of performing the operation, is given in the fifth volume of the American Journal of Dental Science.

After the operation has been performed, the patient should be directed to keep his mouth closed, maintain perfect quiet; avoid coughing, sneezing, or even spitting, and the use of all solid food. He should take very little aliment, and this only at long intervals. For appeasing the cravings of the hunger with which some suffer, Dr. Mütter recommends thin calf's-foot jelly, or

what is known as cold custard slip, as the best nourishment that can be used; but he thinks that nothing should be given until the end of the second or third day after the operation has been performed.

In the performance of the operation of staphyloraphy, however, different surgeons employ different instruments, and adopt different methods of procedure. Professor N. R. Smith, of Baltimore, who has performed the operation many times, and in a good proportion of cases with perfect success, employs a very simple lance-shaped needle, mounted on a handle, and having near its point a slit which opens toward the handle. The needle is broader in front of this slit or eye than behind it, which renders the passage of the back part more easy. Armed with a ligature, the curved portion of the needle is carried beyond the fissure, and its point introduced behind the middle of the uvula; as soon as it has come through far enough to expose the ligature in the slit, this is taken hold of with a tenaculum, disengaged from the slit, and the needle is then withdrawn. A second ligature, in like manner, is introduced half an inch higher up, and, if necessary, a third at an equal distance from the second. With the ends of the ligature passed through the uvula, this part is drawn forward, until the fissure in the soft palate shall assume nearly a horizontal position; its edges are then cut off with a pair of scissors, either straight or curved laterally, or else with a bistoury and a pair of forceps. This done, the ligatures are tied, and the ends cut off.*

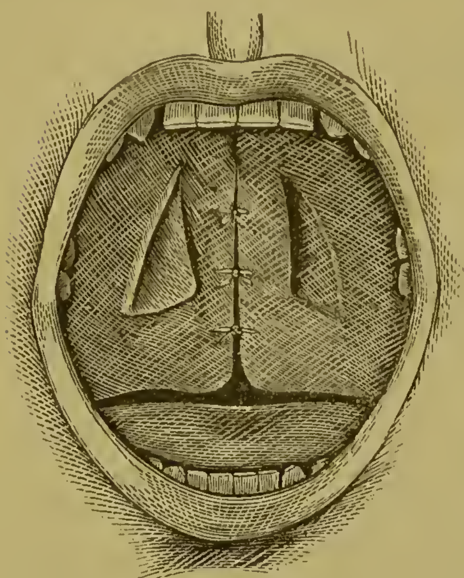
Dr. J. C. Warren, of Boston, who has performed the operation a number of times, uses a needle of his own invention, with a movable point. His son, Dr. J. M. Warren, has also performed the operation frequently, and with very great success. When the fissure extends up into the hard palate, he dissects the mucous membrane from the bone on each side, carrying his knife sufficiently forward toward the alveolar border to form a flap broad enough to meet a like one from the opposite, along the median line. This is the flap operation.

When the fissure is so wide as to prevent the margins of the velum from being brought together, Dr. Mettauer, of Virginia, recommends making several lateral incisions through the mucous

* Appendix to Cooper's Surgical Dictionary, by Dr. Reese, p. 126.

membrane, with a view to increase the extent of the velum, and thus permit their edges to be brought together. For supplying deficiency of structure, Dieffenbach also proposes that a longitudinal incision be made at a short distance from the margin of the fissure, as in Fig. 299, from Dr. Pancoast's Operative Surgery. The last-named gentleman has just performed the operation in two cases, with success. Dr. Mütter, of Philadelphia, who has been very successful in the operation, has also had recourse to these lateral longitudinal incisions, with the most happy results.*

Fig. 299.



Suture of the palate is always difficult, and was, in former days, anything but a successful operation, by reason of the almost impossibility of preventing the flaps, when united, from being dragged asunder by the muscles. To Fergusson is due the great credit of introducing a new principle of treatment in the operation, viz: the application to it of *myotomy*, and thus paralyzing the movements of the muscles of the palate. Fergusson found that the chief causes of failure in these cases was the mobility of the parts and the traction exercised on the line of union by the muscles, principally the levator palati and the palato-pharyngeus. In order to obviate this tension, he conceived the idea of dividing the muscles causing it.

In the operation, as performed by Mr. W. Fergusson, there are four distinct stages. In the first, the muscles of the palate are divided, by passing a curved lancet-ended knife through the fissure behind the velum, midway between its attachment to the bones and the posterior margin, and about half-way between the velum and the end of the Eustachian tube. By cutting deeply with the point of the knife in this situation, the levator palati is divided. The uvula is then seized and drawn forward, so as to put the posterior pillar of the fauces on the stretch, which is to

* Vide Liston's and Mütter's Surgery, p. 204.

be snipped across so as to divide the palato-pharyngeus. The next step in the operation consists in paring the edges of the fissure from above downward by means of a sharp-pointed bistoury. This is best done by seizing the lower end of the uvula, putting it on the stretch, and cutting first on one side and then on the other, leaving the angle of union to be afterward removed. The patient should then be allowed to remain quiet, and to gargle the mouth with cold water or ice, so as to stop the bleeding.

When this is arrested, the surgeon proceeds to the next step—that of introducing the sutures—which may be done by means of a nævus-needle, armed with a moderate sized thread, passed from below upward on the left side of the fissure, about a quarter of an inch from the margin. The thread should now be seized with forceps, and one end of it pulled forward through the fissure. This again may be threaded in the needle and passed through the opposite side of the fissure from behind forward through the right side. As the point of the needle appears, the thread should be again seized, and the needle, at the same time, withdrawn; and, finally, the suture is tied with the surgeon's knot. In this way, from two to four—in any case a *sufficient number*—of sutures may be passed, according to the extent of the fissure, tied tightly, and the knot cut close.

The patient must next be put to bed, and every care taken to avoid any movement of the palate, either by coughing, spitting or swallowing the saliva; giving soft food and very little of it. The sutures need not be withdrawn before the eighth or tenth day, but may be left a few days longer if union be not surely obtained at the period mentioned.*

The operation, already described, of Dr. Warren, of Boston, for closing fissure of the hard palate, has been introduced into England by Mr. Pollock, who, with the assistance of his peculiarly-constructed instruments, proceeds as follows: He makes an incision along the edge of the cleft, at the junction of the nasal and palatal mucous membrane. The soft covering of the hard palate is carefully dissected or scraped from the bones by means of curved knives, great care being taken that the mucous

* Vide Medico-Chirurgical Transactions, vol. 28. Also Erichsen's Science and Art of Surgery, 1859.

membrane and its subjacent fibro-cellular tissue (which varies greatly in thickness in different cases) are not perforated. When this has been well loosened on either side, it will be found to hang down like a curtain from the vault of the mouth—the two parts coming into apposition along the median line, or possibly overlapping. The edges being then smoothly pared, are to be brought together by means of a few points of suture introduced in the ordinary way, and without any dragging. The knots having been tied, the patient must be confined to bed for several days, and nourished with an abundant, but pulpy, diet.

In dividing the levator palati muscle, for relaxing the edges of a fissured soft palate, Mr. Pollock adopts a practice different from that employed by Mr. Fergusson, as already described. Instead of cutting from behind, he passes a ligature through the curtain of the soft palate, so as to contract and draw it forward; and then, pushing a narrow-bladed knife through the soft palate to the inner side of the hamular process, by raising the handle and depressing its point, he readily divides the muscular fibres. This method is safer than that of Mr. Fergusson and easier to perform; and the gap that is left closes without difficulty by granulation, and appears to assist in relieving the tension of the parts.*

Ligatures of silk or thread were formerly used in this operation and in all others of a similar nature; but they have the disadvantage of cutting out and of promoting suppuration. To our distinguished friend, Dr. Marion Simms, belongs the merit of having introduced in surgery the employment of metallic sutures, principally of silver wire, to the exclusion of those of organic material. The intelligence and patience of Dr. Simms deserve our admiration; and his unwearied efforts in perfecting the operation for the cure of vesico-vaginal fistula—an operation which he has made peculiarly his own—are rewarded by the respect and gratitude of the humane and enlightened of all countries.

When the inflammation which follows the operation is very severe, it should be combated by general and local bleeding, and such other antiphlogistic means as the nature of the case may seem to demand. When the inflammation is accompanied by

* Vide Erichsen's Science and Art of Surgery.

cough, Dr. Mütter recommends the administration of opiates. The same author recommends, in case sloughing of the parts takes place, the application, with a camel's-hair pencil, of a solution of the nitrate of silver, or a mixture of creosote and water, three or four times a day.

It often happens, that an opening remains in the palate after the velum has been successfully united. This may sometimes be closed by the granulation of the edges of the cleft, which may be induced by the application of caustic or the actual cautery. Dieffenbach has employed, with success, a concentrated tincture of cantharides, applied several times a day to the edges of the opening.* By some, the actual cautery is preferred; but if the latter be used, it should only be heated sufficiently to blister the parts.† The nitrate of silver and caustic potash have been used, but there is danger of causing a greater loss of substance by the use of these powerful caustics than can be gained by the granulations which they induce.

A surgical operation is seldom performed for the purpose of closing a simple opening in the hard palate. It has been recommended, however, by some surgeons, and when the hole is not very large, the operation of *staphyloplasty* may be successfully performed. In Fig. 300, from Dr. Pancoast's Operative Surgery, the operation, as performed by the author of this valuable work, is represented. So perfectly is it exhibited in the cut, that we do not deem any further description necessary. In the majority of cases of this kind, however, an artificial obturator or palate will be found necessary.

Fig. 300.

* British and Foreign Medical Review, for April, 1846.

† Dr. Hullihen on Cleft Palate in Am. Jour. Dent Science, vol. 5, p. 173.

ARTIFICIAL OBTURATORS AND PALATES.

Although, by the operation of staphyloraphy, the use of mechanical contrivances for remedying imperfections of the palate are often rendered unnecessary, yet, in the majority of cases, it is only by such means that any relief can be afforded. Artificial palates and obturators have been employed for a long time. Both of these terms signify one and the same thing, namely: an instrument to *close* or *stop* an opening in the palate. The former, however, is generally applied to a simple plate fitted to the palatine arch; the latter to a plate surmounted by a piece of sponge, wings, or a drum or air-chamber, passing up into or through the opening, and designed either to hold up the plate or to fill the aperture. When a velum is attached, the instrument is termed an artificial palate with a velum.

They were, according to Guillemean, applied by the Greek physicians; but it is to that celebrated French surgeon, Ambrose Paré, that we are indebted for the first description of an appliance of this sort. This author has furnished an engraving of an obturator which he had constructed in 1585, consisting of a metallic plate, probably of silver or gold, fitted into an opening in the vault of the palate. It was held up by means of a piece of sponge, fastened to a screw in an upright attached to the upper surface of the plate. The employment of sponge, however, was found to be objectionable, as the secretions of the nasal cavities, which it absorbed, soon became insufferably offensive; notwithstanding which, it continued to be used for a long time. Ultimately, however, it was superseded by an obturator invented by Fauchard. This was held up by means of wings, which turned on a pivot. Both of these obturators, however, exerted a hurtful influence upon the surrounding parts, as the pressure produced by the sponge and wings caused them to be gradually destroyed, and thus augmented the evil they were designed to remedy; consequently, their use has been wholly abandoned. We do not, therefore, deem it necessary to give a description of either. We will, however, quote a passage from Bourdet upon the subject. In alluding to the impropriety of having recourse to any appliance which has a tendency to counteract the curative

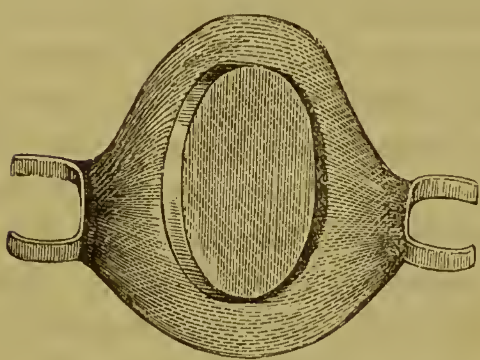
efforts of nature, he says: "Before considering the cicatrized perforations of the palate as being of a nature incapable of diminishing in diameter, practitioners should satisfy themselves, thoroughly and beyond doubt, that such is the case. We do not think that this condition of permanency can exist, for positive facts attest the contrary; and as holes made in the cranium with the trepan close almost entirely, in like manner those of the palate constantly diminish." Numerous examples might be adduced if it were necessary to prove the impropriety of sustaining an obturator by any fixtures which act upon the lateral parts, as they necessarily tend to increase the dimensions of the opening in the palate. Cases do, however, sometimes occur, in which no other means of support seem to be afforded, and then the dentist may, perhaps, be justifiable in using them. We question, however, even in such cases where atmospheric pressure cannot be obtained, and there are no teeth for clasping, if the use of spiral springs, attached to a partial lower piece or to caps placed over the lower molars, would not be preferable to this very objectionable prominence on the upper surface of obturators.

With a view of obviating the objections which have been mentioned as existing to the obturators of Paré and Fauchard, Bourdet proposes to employ simply a metallic plate, fitted to the vault of the palate and large enough to cover the opening, with two lateral prolongations, one on each side, extending to the teeth, to which they are fastened by means of ligatures. This was also found to be objectionable, as the ligatures were productive of constant irritation to the gums; moreover, they did not hold the plate in place with sufficient stability, and its use was soon abandoned. But these objections were both obviated, as we have stated in another place, by an improvement made by M. Delabarre, which consists in the employment of clasps, instead of ligatures attached to lateral branches of the plate; to prevent these from slipping too high up upon the teeth, he attached to each a kind of spur, which was so bent as to come down over the grinding surface of the tooth to which it was applied. The last named author, also, made another modification, which consisted in the application of a drum to the upper surface of the plate (Fig. 301). The object of this was to prevent the accumulation

of mucous fluids from the nose, in the *cul-de-sac*, formed by simply closing the opening below; also to prevent fluids, in swallowing, from passing up between the obturator and soft parts, through the opening into the nose.

The manner of constructing an obturator, with a drum upon its upper surface, is as follows: First take an impression of the entire palatine vault and alveolar ridge in wax. From this, a plaster model and metallic dies are procured, in the manner described in a former chapter; a gold plate is then swaged between the two last, a little larger than the opening in the palate, with a broad arm on each side, extending to the bicuspid or molar tooth, to which a broad clasp is fitted and soldered. Secondly, an impression of the opening in the vault of the palate is taken with wax, properly softened and placed upon the upper surface of the palate plate, using the precaution to prevent forcing it up too far through the aperture; this is next trimmed where it comes in contact with the plate, so that it shall not be quite as large as the opening; it is then covered with plaster, after which a metallic die and counter-die is taken, then a gold plate is swaged between the two, and this last is fitted and soldered to the palatine plate. The piece, after being properly finished, is ready to be applied.

Fig. 301.



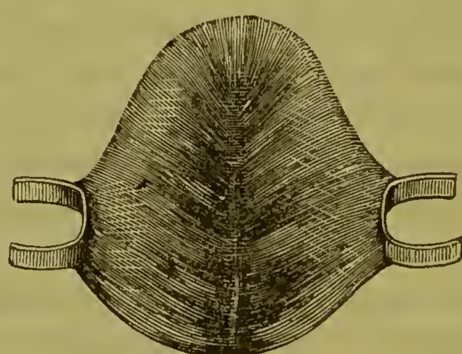
An obturator of this description is seldom required, except in those cases where the opening in the palate is connected with the velum, so that by the contraction of its muscles, the parts are raised from the plate in such a manner as to permit fluids, in the act of deglutition, to pass up into the nose. In this case it will not only prevent this difficulty, but will also prevent the fluids of the nose from accumulating in the opening above the plate.

It is of the greatest importance that an artificial palate or obturator should be executed in the most perfect manner, and be made to fit accurately to all the parts with which it is to be in contact, so that it may not produce the slightest irritation or

exert undue pressure upon any of the surrounding parts. As in the case of the application of a dental substitute, the piece should not be applied while any of the teeth, especially those of the upper jaw, are in an unhealthy condition. The gums and sockets of the teeth should also be free from disease. The drum evidently offers the same impediment to nature's efforts in closing the opening as the obturators before mentioned; on this score, therefore, it is equally objectionable. The best way doubtless to prevent the accumulation of secretions, food, &c., is to remove the piece two or three times every day, and thoroughly cleanse both it and also the teeth to which the clasps are applied.

When the opening in the palate is small and has no connection with the velum, it is unnecessary to raise the upper surface of the plate by attaching a drum or air-chamber to it. If it be accurately fitted to the vault of the palate, it will effectually prevent fluids in deglutition from passing up into the nasal cavities, or the escape of any portion of the voice through the opening; and by frequently removing the plate, it will prevent the accumulation of the secretions in the *cul-de-sac*. A simple plate like the one represented in Fig. 302, will be all that is required to remedy the defect; and this, in fact, will probably be found the best form for all cases, whether the openings be large or small.

Fig. 302.



Although the stability of the plate will very much depend upon the width of the clasps, the latter should never be so wide as to press upon the gums around the necks of the teeth to which they are applied, as in that case they will be productive of irritation, and ultimately cause the destruction of the alveoli and loss of the teeth. Nor should they press upon the teeth so as to force them apart or draw them toward each other, as, in either case, the effect would be gradually to loosen and displace the organs. In short, the same precautions are necessary in the application of clasps to an artificial-palate plate, as to one designed merely to serve as a support for artificial teeth.

All the details of construction are the same in the case of simple obturators as in the making of an upper plate. If a drum is soldered on the upper side of the plate after the plan of Desirabode, or if a very deep arch is made shallower by soldering a second plate on the lingual side, a small hole must be made for the escape of heated air in soldering, which may afterward be closed with a gold screw, and filed off smoothly.

AN ARTIFICIAL PALATE, WITH A VELUM AND UVULA.

It sometimes happens, in cases of congenital fissure of the palate, that the margins of the velum are so far apart as to preclude the possibility of uniting them by any surgical operation, and, at other times, these parts are wholly destroyed by ulceration; it is in such cases that an artificial velum is required, and to supply which, the ingenuity of art has been taxed to its fullest extent. Various mechanical contrivances have been invented for this purpose; but it is scarcely necessary to say, that until quite recently, none have been constructed which have performed, to any considerable extent, the functions of the natural parts.* Nor has this desirable object, even yet, been very fully accomplished. One of the most ingenious contrivances of the kind which has ever been invented, was recently constructed by Mr. Stearns, surgeon, of London. The principle, however, upon which it acts, was not altogether original, as M. Delabarre had previously constructed a piece of mechanism

* The inventions and improvements above referred to as of recent development, date back as far as 1842. Since then, great advances have been made in this beautiful and most practical art—greater, perhaps, than all made prior to that time. Dr. Norman G. Kingsley, of New York, has for several years past made a specialty of this department of our profession, bringing to it skill, invention, and perseverance, which have produced results of almost marvelous character. To the knowledge of the writer, patients of his, whose speech up to a few months ago had been scarcely intelligible—some of them so for more than forty years—to-day speak with a distinctness, precision, volume, and finish of enunciation, scarcely distinguishing them from those by whom they are surrounded; a slight peculiarity of tone is alone noticeable in their voice. A few more lessons from their instructor, Mr. J. H. Brown, the distinguished elocutionist of that city, will, it is believed, entirely remedy this only remaining defect.

We have given, on pages 843—853, a description of Dr. Kingsley's method of practice, so full and complete, that by their direction any operator of skill and capacity will be enabled to produce results of the same practical character with those referred to. W. H. D.

somewhat similar to it, and composed of the same material, though of a less perfect quality.

The contrivance employed by Delabarre, consisted of a metallic plate, bent in the form of a horse-shoe, and occupied the place of the posterior part of the naso-palatine floor; the nasal portion was grooved for the reception of the vomer. The palatine surface was concave, and made to resemble the vault of the palate. From each side of this, an arm projected to the first molar, to which it was secured by means of a clasp. To the posterior portion, a piece of caoutchouc, resembling in shape the form of the velum and uvula, was attached. Although this instrument is represented as having performed all the functions of the velum, so far as deglutition and speech are concerned, we are disposed to doubt the entire correctness of the statement, as it has failed to do so in other cases in which it has been applied, much advantage, however, in some instances, has certainly been derived from it.

The instrument constructed by Mr. Stearns consists of a plate of gold, fitted to the vault of the palate, in the usual manner, and to the upper and posterior margin of which is attached a flat spiral spring, admitting of easy vibration backward and forward; to the posterior extremity of this is attached a flexible velum, "constructed of Mr. Goodyear's preparation of caoutchouc, which has the property of resisting the action of both oils and acids, and at the same time of sustaining a high degree of heat. The body of the velum consists of the lamina of caoutchouc, of a somewhat triangular form, and of the same size and shape as the vacant space it is intended to occupy—the place being that which would be indicated by imaginary lines, connecting the opposite sides of the columns, and subtending the vertical angle of the fissure, at which point the velum is connected to the posterior extremity of the spiral spring. The lamina, constituting the body of the velum, is divided into three pieces, which overlap each other. The wings project obliquely forward and outward from each lateral margin of the body, and being made to conform to the shape of the columns or sides of the fissure, are seen to rest upon their inner and anterior surfaces, thus covering a portion of the soft parts which constitute the boundaries of the posterior fauces. In like manner, along each lateral margin of

the body, there is a flange, projecting obliquely, backward and outward, and extending along down the posterior surface of the column, terminating at the inferior angle of the velum. In this way the wing and flange together, on the same side, form a groove fitted to receive the fleshy sides of the fissure. As the preparation of caoutchouc made use of, presents a smooth surface, and yields readily to the slightest pressure, it is found to permit the contact and muscular action of the surrounding soft parts, without causing any irritation. When, therefore, the sides of the fissure tend to approximate, as in deglutition, in gargling the throat, or in the utterance of some of the short vowel sounds, the three parts of the body of the velum slide readily by each other, thus diminishing the extent of exposed surface, and thereby imitating, to some extent, muscular contractile action, the force being derived from without, and not, of course, contained within the instrument. During the effort made in speaking, the surrounding muscular parts embrace and close upon the artificial velum, and press it back against the concave surface of the pharynx. The passage to the nares being, therefore, temporarily closed, the occlusion of sound is accomplished, and articulation made attainable; since the voice or sound, as it issues from the glottis, is thereby directed into the cavity of the fauces, and confined there long enough to receive the impressions made upon it by the tongue, lips, etc., in the formation of the consonant letters."

A velum constructed after the foregoing manner, Mr. Stearns thinks, will be found applicable in all cases, though it will be necessary, in the construction of the palate plate, to give it such form and dimensions as may be required by the peculiarities of each case. For example, when the fissure extends through the alveolar border, or when some of the front teeth are wanting, it will be necessary to extend it sufficiently forward to close the opening, or serve as a base for such dental substitutes as may be required.

Through the courtesy of Dr. E. G. Tucker, of Boston, we are enabled to add to the foregoing description an engraving of the instrument, made from a duplicate, which he sent to us since the publication of the fourth edition of this work, of one which was constructed by himself and his brother, Dr. J. Tucker.

In Fig. 303 is seen the lower surface of the palate-plate and anterior surface of the velum. *a*, the palatine plate; *b*. the flat

FIG. 303.

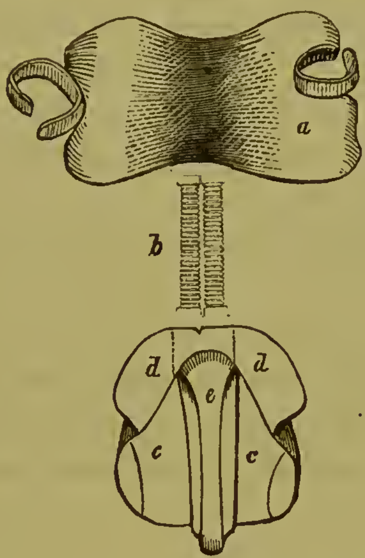
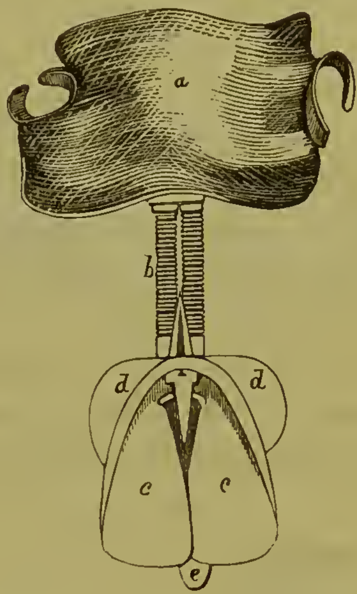


FIG. 304.



spiral springs, extending from the posterior margin of the plate to the upper part of the velum; *c c*, wings of the velum; *d d*, the flange; *e*, the central portion.

Fig. 304 shows the upper surface of the palate-plate, and the posterior surface of the velum and spiral springs. *a*, palate-plate; *b*, spiral springs; *c c*, wings of the velum closed; *d d*, the flange, as seen above the wings; and *e*, the central portion below the wings, and intended to represent the uvula.

Fig. 305 represents the velum with its wings separate from the plate, showing the central portion, before being attached to the hook, at the lower extremity of the flattened spiral springs. In Fig. 306 is represented a side view of the velum, showing the groove between the flange and the wings, for the reception of the fleshy sides of the fissure.

FIG. 305.

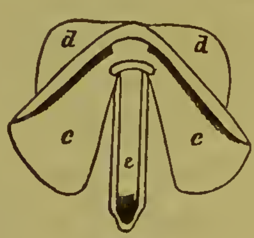
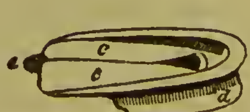


FIG. 306.



With a view of restoring the air passages to their normal condition in those cases where the velum has been lost by disease, Dr. S. P. Hullihen invented an instrument consisting of a palate plate with a bi-globular valve attached to it in such a manner as to permit the egress

and ingress of the desired volume of air. We will quote from vol. i., New Series of the American Journal of Dental Science, the description which Dr. H. has given of the instrument.

"An artificial palate made upon this plan will be composed of four parts: 1st, a valve, made from gold-plate, as thin as it can well be worked; 2d, a spiral spring about an inch long, and of the size usually made for whole sets of teeth; 3d, a slide, one inch and a half in length, and of the width and thickness of a common watch-spring; 4th, a plate, larger or smaller, as the case may require, struck up in the usual way, to fit the roof of the mouth.

The size and form of the valve is obtained by taking an impression of the posterior opening of the nares. The plate composing it should be struck up in two parts, front and back. which. when soldered together, makes a hollow body (*a*), as shown in Fig. 307. At the upper end of the valve a small pin is soldered, the point of which looks downward, and of sufficient thickness to fit very tightly in one end of the spiral spring. The spiral spring must be made of such a length as will permit the valve to rest slightly upon the upper surface of the remnants of the lost velum. The slide has a pin in the posterior end, looking upward to receive the other end of the spiral spring before described. The anterior end of the slide has a small button looking downward. The slide is attached to the plate by two small clasps (*b b*), as represented in Fig. 308. The plate may be made to cover the entire roof of the mouth. when necessary; or it may be made only sufficiently large to permit the mounting of the slide. These different plates, when put together, particularly if the plate is to cover the whole roof of the mouth, make a plate of the form represented by Fig. 307.

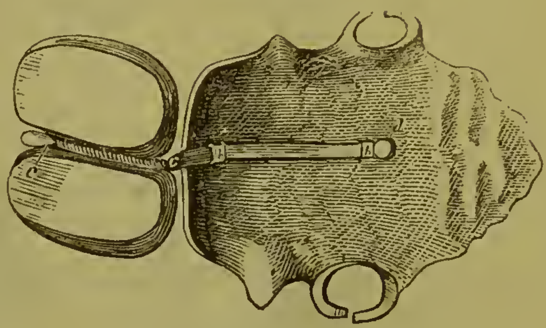
Fig. 307.

Fig. 308 shows the attachment of the spiral spring to the valve and slide (*c c*). The staples (*b b*) confine the slide to the plate, and there is a button (*d*) on the end of the slide, by which

the valve may be set back or forward, as desired by the patient, without removing the plate from the mouth.

The plate should be made to fit the several parts for which it is intended, with great exactness. The plate must fit the roof of the mouth, and the teeth to which it may be secured, in a faultless manner. The slide must be arranged so as to permit the valve to be drawn so closely against the posterior opening of the nares, as to close them, or to be pushed back, so as to leave them entirely unobstructed. The spiral spring, as I have before remarked, must be made of such a length as will allow the valve to rest slightly upon the upper surface of the remnants of the lost velum. The valve should be sufficiently wide at its base to overlap the remnants of the velum so far as the parts on each side will permit, without producing irritation. No other part of the valve than the base should be allowed to touch, unless when brought forward against the nares. Unless all the parts are so arranged, the palate will not be properly constructed, and will not, of course, answer the desired end.

Fig. 308.



"Thus it will be perceived that the peculiarities of this plate are: First, a valve to fit the posterior opening of the nares; second, the attachment of this valve to a slide, by which the patient is enabled to adjust the valve while in the mouth in such a way as to admit through the nares just the quantity of air desired; third, the mounting of the valve on a spiral spring, which will permit it to vibrate backward and forward, as the breath is inhaled or exhaled, and also to be moved by any muscular action that may remain in the remnants of the lost velum, thereby answering, to a great extent, the purposes of a velum."

All the benefit which it is possible to be derived from an appliance of this sort may, in the majority of cases, we believe, be secured by this instrument. We met with one case, however, in which the muscular action of the remnant of the velum against the valve excited so much irritation and nausea, that it could

not be worn. To obviate which, Dr. A. A. Blandy constructed a palate-plate of a somewhat different shape, as may be seen from Figs. 309, 310, with a valve composed of two pieces.

Fig. 309.

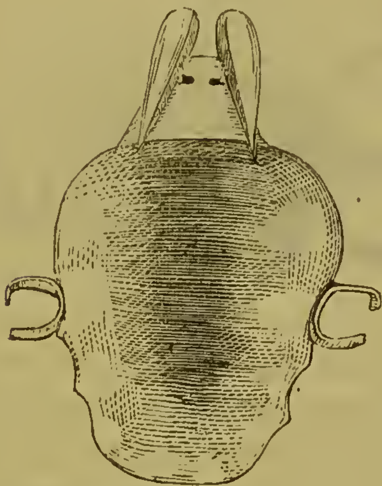
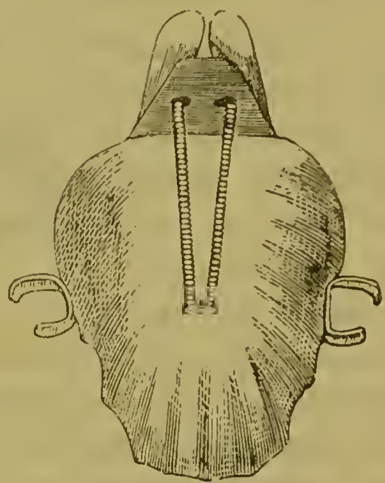


Fig. 310.



To the posterior edge of the palate-plate another plate is soldered. This is about five-eighths of an inch in width where it is united to the palate-plate, and half an inch at the posterior extremity, extending upward and backward nearly three-fourths of an inch. The two pieces composing the valve are fixed to the lower surface of the plate in such a manner that the contraction of the remnant of the velum moves them toward each other. But upon its relaxation they are immediately separated by two spiral springs, attached to the upper surface of the palate-plate at one end, and to two delicate springs passing through the plate, united to the posterior edge of the first-mentioned plate, and attached on the lower surface, one to each part of the valve. The two pieces composing the valve are hollow, each about seven-eighths of an inch in length, and of a conical shape. The bases of the cones are placed posteriorly and the apices anteriorly. The surfaces moving on the plate which projects from the palate-plate are flat, and the outer angle of the base of each is rounded. But the several parts of the whole appliance are so distinctly shown in Figs. 309, 310, that we do not deem a further description of them necessary. In Fig. 309 is seen a lower, and in Fig. 310 an upper, view of the apparatus, the two pieces composing the valve being purposely separated to show them more distinctly. This apparatus had been worn with

the greatest comfort and satisfaction for six months prior to the issue of the seventh edition of this work. Its subsequent history is not known. The patient's speech, although not perfectly restored, was greatly improved, as were also the functions of mastication and deglutition.

DR. KINGSLEY'S ARTIFICIAL VELUM AND PALATE.

In the treatment of congenital fissure of the palate by mechanical means, with a view of improving the articulation, this one fundamental principle must be kept in view. It is not alone the too free escape of sound through the nares that causes the defect of speech; but it is the absence of a flexible curtain or valve, which at times will perfectly close the passage to the nares and direct the sound into the mouth, and at other times allow a portion or all the sound to pass through the nose. It is under such circumstances that all metallic obturators, no matter how ingeniously constructed, are not only clumsy and troublesome contrivances, but ineffectual to accomplish articulation. They serve only to plug the nares, which the patients might do for themselves by stopping the nose with cotton, or by any other simple means, and still be as far from any material improvement of speech as ever. Metallic obturators may make speech easier for the patient, but rarely any more distinct. An elastic flexible artificial velum, to replace the lost organ, is the only mechanical contrivance which can assist in producing this desirable result. To Stearns great credit is, undoubtedly, due for having demonstrated, by his experiments, that an artificial velum can be constructed, which may be worn in the fissure without discomfort, and be made available for accomplishing perfect speech. But to Dr. Kingsley is certainly due the credit of having taken up the matter where Dr. Stearns seems to have left off; to have made such improvements in the perfection and simplicity of the instrument, and to have reduced the manner of accomplishing it to such system, as to leave success no longer problematical and dependent upon chance, but a certainty, dependent only upon the skill of the operator. We can speak from our own knowledge, having seen some of his cases; one, in particular, which presented the apparently insurmountable obstacle of the

entire loss of the natural teeth, not a tooth left from which any support could be obtained for such an appliance; and yet, in this case, the velum, by the beauty of its adaptation, was not only self-supporting, but actually sustained an entire upper set of teeth with as much firmness as is ordinarily obtained from spiral springs.

The cases of congenital fissure of the palate most commonly met with are when the fissure, commencing with a division of the uvula, extends forward through the soft palate, terminating at about the centre of the arch, or at the base of the alveolar ridge. Although they differ materially one from another in their outline, there are certain general characteristics which are common to them all, and which can be made available for that support of the artificial palate or velum, upon which its success depends; so much so, that the ingenious and skillful dentist can adapt the same principle in the construction of the instrument to almost any case, even if the fissure extends entirely through the alveolar ridge in front. A prominent and important characteristic is a recess, beginning at the lower end of the remnant of the velum, and extending up behind it on either side, until it terminates in the nares, or, in the absence of the septum, uniting in front of the apex of the fissure. In some cases, the septum is united to one plate of the maxillary bone, extends a little distance back of the apex of the fissure and forms on one side its boundary. In such cases, however, it ends abruptly, and the recess behind the edge of the fissure as abruptly commences. It will thus be seen that the fissure presents somewhat the character of an opening through a curtain or roof, and which can be taken hold of on both sides nearly or quite around its entire distance. It is essential that a knowledge should be gained of the conformation of this recess behind the remnant of the soft palate, back; behind and above the bone, forward; and at the apex.

These parts are out of sight, but a pretty accurate knowledge of their form and relation to each other must be obtained. This brings us to a consideration of the most important part of the whole operation, viz., the getting of an accurate impression of the fissure throughout its entire length, of all the parts exposed, behind and above it, and of all that portion of the roof of the

mouth and the anterior face of the soft palate contiguous to it. An impression can be taken by a skillful operator of all these contiguous parts, reaching even some little distance below the remnant of the uvula, and representing the whole chamber and walls of the pharynx. We have seen an impression taken by Dr. Kingsley, which reached full three-fourths of an inch below the uvula, and representing fully the chamber and posterior walls of the pharynx. To do this successfully, and get a representation of the soft and muscular parts in their quiet state, requires the utmost exercise of patience and perseverance, skill, gentleness and firmness on the part of the operator; and, on the part of the patient, perfect confidence, and that cessation of muscular movement which can be gained by training or handling the parts.

In taking an impression, plaster of paris as is used for other operations in dentistry, is by far the best substance that can be employed. When properly mixed, it will not disturb in the slightest degree the most delicate structures, which can be said of no other substance now used for such a purpose. Ordinarily several sittings will be required before a full impression of all these parts, at once, can be obtained. Unless the soft or muscular parts have been trained to quiet by handling, they must be educated to bear the presence of an impression. This may be accomplished partly by the patient using a bit of soft sponge attached to the end of a stick, and bathing the parts with some mild astringent wash several times a day. It is also well to take a a partial impression, say such as would be required for an upper set of teeth, and at the next sitting gradually encroach upon the delicate ground. In this way a full impression may be taken after a few sittings with no more apparent inconvenience to the patient than the first or partial one. It will facilitate the success of matters if from the first impression a model be made and an impression cup struck up, conforming somewhat to the opening, and reaching far enough back to support the plaster from dropping in the throat. It will also be necessary to remove the plaster as soon as it has stiffened enough to keep its form, as it will be found dovetailed above the bone at the apex of the fissure, and if allowed to remain until hard, cauld not be removed without injury to the surrounding structures. By removing before it has hardened, it will break on a line with the fissure, and the

piece above may be slipped back and taken out at leisure. It will also tend to ensure the success of the impression, to place the soft plaster first above the opening at the apex with a small curved spatula, and then to carry the plaster in the impression cup immediately against it. Success will be also dependent very much upon the skill of the operator in managing his plaster, mixing it to the proper consistency, and using, and removing it, at just the right moment.

The plaster model had better be made so that the part of the model which represents the posterior nares may be removed from the remainder, so as to bring the parts above the fissure more immediately under inspection. This model may be compared with the natural parts in their quiet state, to ascertain its correctness. Trifling alterations of form about the remnant of the uvula may be made on the model, but if great discrepancies appear, a new impression must be taken. On this plaster model may be adapted an artificial velum of any plastic substance: sheet gutta percha is very good, (consult Figs. 312, 313, page 849 for a better understanding of the following description.)

Let it reach across the fissure, extending from the apex, following the curve of the soft palate down past the uvula, and of sufficient length to reach the pharynx when contracted upon it, carry a wing of it behind the edges of the fissure to the full depth of the recess, along the whole length, and another wing forward, partially covering the anterior portion of the soft palate, like a flange running from a point near the uvula clear around to the opposite point, E. This flange to extend about half the distance from the edge of the fissure, to the base of the teeth. The wings and flange to be modeled about the thickness of an ordinary card; the body reaching across the fissure, double that thickness; and the forward part resting upon the top of the bone D, D, thickened up three or four times as much according to space, as on the firmness and accurate adaptation of the instrument on this ledge of bone at the apex depends a great deal of its security. Model the whole so as to restore as much as possible a natural form to the dome of the mouth. We have now an artificial velum which as to form, simply to fill the cavity, is all that is necessary; but which, to be made of use, must be changed for an elastic and durable material. It must provide for contraction, as when the

muscles operate against it; it must be flexible, easily moved, delicate, capable of no injury to the parts with which it is in contact, also elastic, falling immediately into its natural place when the pressure is removed. It must also be provided with means to hold it in its place. To secure all the above mentioned qualities, elastic vulcanized rubber is the only material now known to the profession which will answer the purpose. Properly prepared, it possesses the inherent quality of instantly returning to its place when pressure is removed; but to provide for its contraction upon itself when the muscles act in that direction requires a mechanical arrangement of its parts; the only way seems to be to form it in leaves or laminæ which shall overlap and slide upon each other under pressure.

Stearns' velum was formed of three pieces, being slit up from the posterior end nearly to the apex, and a flap covering the slit, under which the two halves slide past each other. Of it he says, (Vide Vulcanite, vol. 1, page 78,) "I wish here to be understood as saying in exact terms, that I consider the slit and opening through the centre and its closure by a sort of valve on the anterior surface, as an essential feature of all artificial vela," and again, "I am confident that this one feature will be preserved in all successful obturators." But later developments have proved how unwise it was to so narrowly limit the perfection to which a mechanical arrangement may be carried. It is not at all necessary, that the instrument should be composed of three pieces; an equally effective, and in some cases a superior velum, may be made of only two pieces; hence, it is merely a matter of convenience, not an essential feature. The process to be followed in making a mould in which to vulcanize an elastic-rubber duplicate of the model artificial velum, already obtained, is an exceedingly intricate one.

It will be utterly impossible to give detailed specific directions for making the mould. General directions only can be given, and to the skill and ingenuity of the dentist, must be left the carrying out to perfection of many of the minor details. To any one who understands the sculptor's art of piece-moulding or making a mould in sections, it will be comparatively easy.

The great point to be gained, is to obtain an elastic duplicate of the model velum, making such separations in it as will provide

for its contraction. For such purpose, plaster of which a mould might be easily made, will not answer. An elastic velum made in a plaster mould presents a surface covered with little excrescences which cannot be polished off, and which seriously impair its efficiency. Type metal is a very excellent material, being easily worked, presenting a clean fine surface, and making a durable mould, from which any number of vela may be obtained.

The mould should consist of six or seven prominent pieces, which may be first made of plaster, moulded in sand, and duplicated in metal. The division of the separate parts of the velum takes place after it is packed in the mould, and before vulcanizing. A very good plan is to make a trial piece, by vulcanizing an elastic velum in a plaster mould, (without any attempt to make it in divisions,) which can be placed in the fissure to ascertain the correctness of the adaptation, always preserving intact the original model-velum. If the trial piece is not accurate in its adaptation, the model velum may be correspondingly altered. The model itself being rigid cannot be inserted in the fissure for trial, hence the necessity for an elastic duplicate trial piece. This course, if followed before the permanent metal mould is made, may save many tedious alterations. A careful examination of the accompanying illustrations will convey to the reader all the additional explanations which can be given in this article.

Fig. 311.

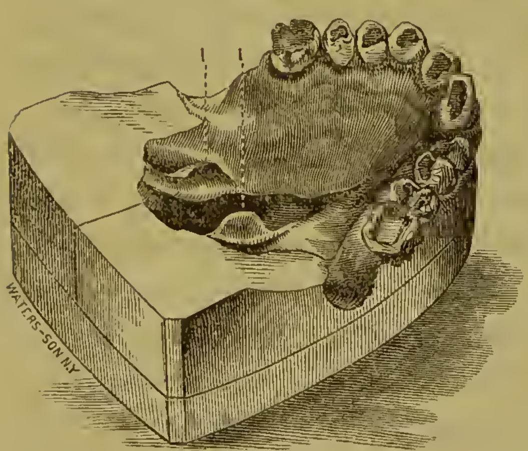


Fig. 311 represents a plaster model of the jaw, of a patient aged 16, with fissure of the palate. The letters I, I, show the beginning of the fissure with a division of the uvula. The horizontal line around the model, and similar perpendicular lines on the anterior and posterior parts, indicate the divisions, into which the model may be made for convenience.

Fig. 312. An artificial velum or palate made in two divisions, which overlap and slide upon each other. The letters A, A, indicate the posterior ends of these leaves. To support the lower

leaf in a horizontal position, the double arched bow B, is attached, as represented, to the sides of the instrument, with a perpendicular connection passing through the slot C, in the upper leaf, and attached to and supporting the lower leaf, without in any way impairing the contraction of the instrument. This bow is of the same material as the body of the velum, and continuous with it, not made separately and attached to it. The two projections marked D, D, pass above and rest upon the bone at the sides, and in front of the apex of the fissure. E shows one of the wings, which partially covers the anterior face of the soft palate. The reader will bear in mind that these engravings are reduced nearly one half; so that artificial vela and the moulds in which they are made, are about twice the size represented in these figures.

Fig. 312.

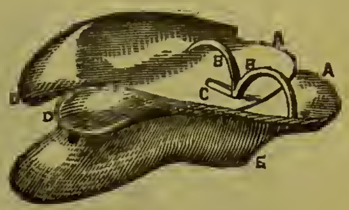


Fig. 313.

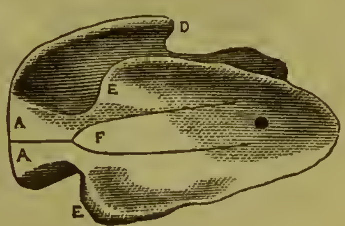
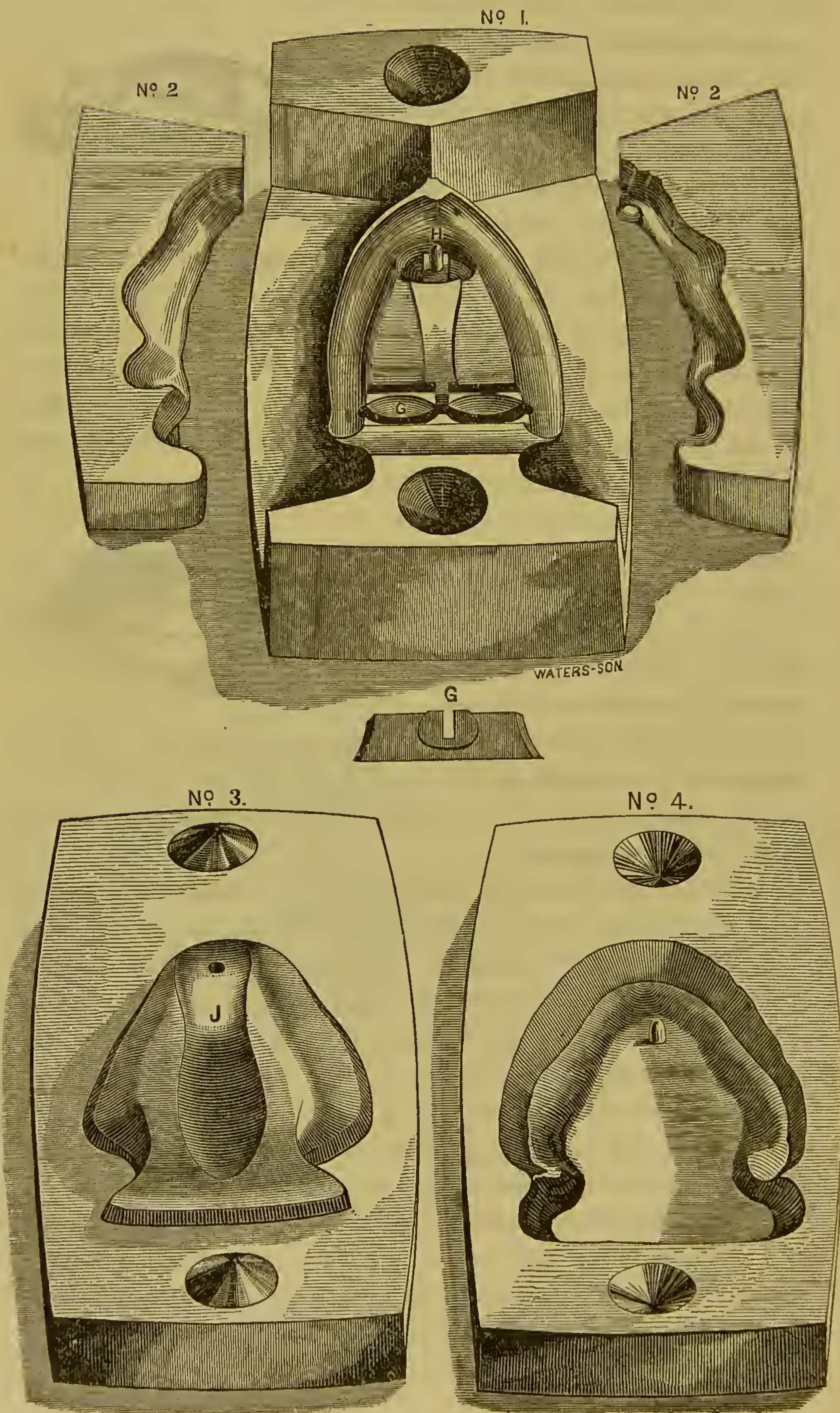


Fig. 313 represents a velum of three divisions. The body of the velum is separated from the posterior end to near the apex of the fissure, and the flap, F, covers the slit. The flap is supported on the other side, by a double arched bow and attachment, as in Fig. 312. The same letters refer to the same points in both drawings.

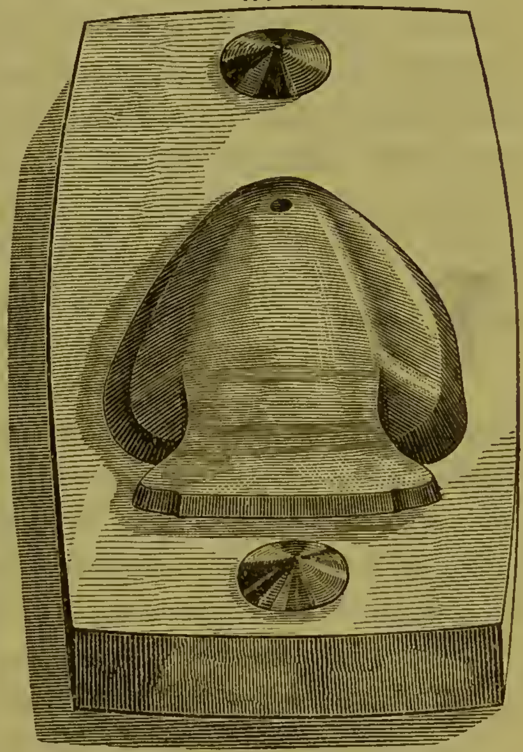
Fig. 314 shows the type metal mould. This mould is for packing and vulcanizing an elastic velum of three divisions. No. 1. Main piece or base of mould. The small block, G, is adapted to the mortise in the base also marked G. When in position, there is an opening through the centre of the block, and a groove from this opening passing out each side from under the block. This groove provides for forming the double arched bow as seen in Fig. 312. The pin, H, provides for a hole in the velum by which it is connected with a plate in the mouth, which assists in its support. No. 2. Two side blocks. No. 3. Top piece of mould with a depression, J, to form the flap of the velum. No. 4 is used in connection with No. 3, to mould the flap separately, and afterward transfer it to No. 1. No. 5. Top piece to mould; but without depression to form the flap, as in No. 3.

FIG. 314.



To pack a velum, elastic rubber, peculiarly prepared for this purpose must be used. Cover with a solution of soap, all that part of the mould which will come in contact with the rubber, which will prevent the rubber from sticking to it when vulcanized. Put the side blocks, No. 2, in place, and pack the space with rubber until filled. Put on top piece No. 5, and warm the mould, and press it together with strong clamps. Cool off the mould and open; if imperfectly packed, add more and press again. In the meantime pack the depression, J, in No. 3, with rubber, using No. 4 to press it into shape. Remove top piece No. 5 from the mould, and put No. 3 containing the flap in its place, previously slitting the body of the velum, from the posterior end to near the apex, and put a slip of paper into the slit to prevent a union in vulcanizing. Put also a piece of paper under the flap for the same purpose, permitting the flap to unite at the forward end with the body of the velum.

FIG. 314.



Different rubber compositions require different degrees of heat and lengths of time for vulcanizing. A composition used for this purpose successfully, has required four hours of steam heat, running gradually from 230°, and ending at 260° Fahrenheit. The attachment to keep the velum in position in the mouth, may be very simple. If the adaptation according to the foregoing method be as accurate as professional skill can make it, the velum will only require such support as shall prevent its inclination to slip down the throat. In ordinary cases where a portion of the natural teeth are remaining, a plate may be made reaching from the molars on one side across the mouth, to the molars on the other side, and attached with clasps, as used in cases of partial

sets of teeth. Where no teeth remain, an upper artificial set may be made in the usual manner. In either case all the attachment to the velum necessary is such as will keep the velum closely up to the apex of the fissure, without straining it from its natural position, and yet allowing an easy lateral motion. A method easy of accomplishment, is to fit a gold tube with an opening on one side through its entire length, to the hole in the forward part of the velum. (Fig. 315, No. 1.) This tube may be secured in its place by any means which will keep it from turning around. To the posterior part of the mouth plate, attach an upright pin of the size of the bore of the tube, and to the upper end of the pin a small square projection, in the form of a key, (Fig. 315, No. 2.) Arrange the parts, when adapted to each other, so that the key will pass through the tube and turn around. To secure the velum to the plate beyond any possibility of its becoming detached when *in situ*, the key must turn in a different direction from the slot in the tube. This will not of course prevent the velum from being swung around on this pivot and detached at pleasure, when out of the mouth.

Fig. 315.

To put this somewhat formidable apparatus into its place, especially when united to an upper set of teeth, would seem at first sight almost impossible, but with a little practice there is no difficulty. The throat has already been educated to bear the presence of a foreign body, and by carrying the velum well down the throat until the forward projections will slip behind the remnant of the soft palate, it can readily be brought forward and upward, to its place and the mouth plate secured.

The practical advantages resulting from the wearing of such an instrument, have already been demonstrated by years of experience, beyond any question. The organs of speech alone are congenital; speech itself, resulting from their use, a faculty which man acquires only through practice. It follows then that where the organs of speech are perfect, the only limit to their exercise is the capacity and perseverance of the patient.

With a fissure of the palate, distinct articulation is impossible. An artificial velum replaces as far as practicable by mechanical means, the lost organ, and renders perfect speech posssible just so far as it correctly substitutes the natural organs. No great

or immediate improvement is observed, nor is to be expected. From long practice, even in the youngest patients for whom it is advisable to operate, bad habits in attempting articulation have been formed which have become almost permanent; these must be broken up and, in a sense, the patient must begin anew to learn to talk. It will be readily seen then that the age of the patient at the time of the operation has an important influence on the final success. In young persons, with sufficient sensitiveness to the defect, to impel them to perseverance, and with such suggestions and instruction as may be of assistance, a few years may be expected to develop such improvements as shall entirely conceal the defect from the ordinary observer; and in some cases this has already been accomplished in a much less time.

In persons more advanced in life, bad habits are more firmly fixed, and a longer time will be required, and it is not improbable that certain peculiarities might never be overcome. In all ordinary cases, a well adapted artificial velum presents to the eye of the physiologist as much perfection in its movements, as it would seem possible to attain in a mechanical contrivance. It is capable of being raised, depressed, and contracted, at will, by the power of the muscle in the remnant of the natural velum; in short, performing to all appearances, all the functions of the natural palate.

ARTIFICIAL PALATES AND OBTURATORS, COMPLICATED WITH ARTIFICIAL TEETH.

When an imperfection of the palate, whether the result of malformation or accident, is accompanied by the loss of one or more teeth, and especially from the anterior part of the mouth, the plate which is employed for remedying the former should be so constructed as to serve as a base for a substitute for the latter. The idea of complicating a palate-plate with artificial teeth, as the author has stated in another place, originated with Fauchard. When a palatine obturator and artificial teeth are to be applied at the same time, they may be connected, and the piece made to answer an excellent purpose, provided there be healthy and natural teeth in the upper jaw to sustain it.

It the construction of an artificial palate or obturator, to which artificial teeth are to be attached, a gold plate of the proper size should be fitted to all that portion of the vault of the palate and alveolar ridge which is to be covered by it, with a lateral branch on each side extending to the first molar, or the tooth to which it is to be clasped. To these, clasps should be soldered, and afterward artificial teeth fitted and secured in the manner described in Part Sixth of this work. If, however, the upper surface of the plate is to be surmounted with a drum or air-chamber, this should be done before the teeth are attached to it. In Fig. 316 may be seen the engraving of a simple palate-plate or obturator, with the central and lateral incisors attached to it.

Fig. 316.

When the teeth have all been lost on one side of the mouth, or are too much decayed to serve as a support for an obturator, either with or without artificial teeth, the plate may be constructed with two branches upon the other side, if there be two healthy and firmly articulated teeth, to which clasps can be applied. A piece applied in this manner, in connection with nine artificial teeth, namely, the four incisors, two cuspids, two bicuspids and one molar, is shown in Fig. 317. The clasps, as may be perceived by the cut, are intended for a second bicuspid and second molar. Although the molars on the opposite side of the jaw were absent, it was not deemed prudent to increase the weight of the piece by attaching more than nine artificial teeth to the plate.

Fig. 317.

An artificial palate, complicated with ten artificial teeth, namely, the central and lateral incisors, the cuspids, the first bicuspid of the left side, the first and second of the right, as well as the first molar, is represented in Fig. 318. The clasps, as may be seen, are for the first molar of the left side and the second of the right. The opening in the palate to be covered by the plate, in this case, extended from the alveolar border backward a little more than an inch, and was about seven-eighths of an inch in width.

Fig. 318.

The functions of mastication, deglutition and speech, which were all very greatly impaired by the opening in the palate and loss of so many of the teeth, were, in a great degree, restored by the piece here represented.

The author would here refer to an obturator, complicated with artificial teeth, constructed by Mr. Warren Rowell, of New York. The great difficulty to be overcome in this case, according to report made of it by Dr. Griscom,* was the want of teeth in the upper jaw to sustain it, and the great size of the opening in the palate, the vomer and turbinated bones having been destroyed. Upon examination, however, Mr. Rowell found that the posterior portion of the palatine aperture was formed, "to a considerable extent, of a semi-cartilaginous substance, possessing sufficient elasticity to allow a larger body than the opening to be pushed up through it, and that when so forced up, it would be supported above the aperture by the edge returning to its original position." This, he hoped, would support a light plate, if the obturator could be so shaped as to rest upon the cartilaginous ledge, after it was introduced.

Without quoting the description which is given of his method of procedure, it will be sufficient to state, that the obturator which he constructed consisted of a plate larger than the open-

* New York Journal of Medicine, vol. viii, No. 23, p. 187.

ing in the palate, and covering the anterior part of the alveolar ridge, to which artificial teeth were attached, and an irregularly shaped drum or air chamber, larger above than below, where it was connected with the palate plate. The neck of this bulb or drum is of the exact size of the opening in the palate, and the upper part or summit has several depressions, which correspond with the irregular surfaces of the remaining nasal bones.

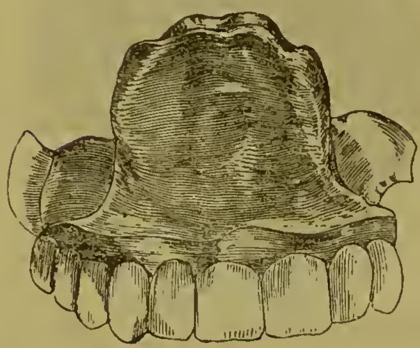


Fig. 319.

Fig. 320.

The anterior part of the palate plate, to which the teeth are attached, as may be seen in Fig. 319, is composed of two plates, to compensate by its thickness for the deficiency of the alveolar ridge. The drum is seen rising from the palate plate, to which it is soldered. In Fig. 320 is represented a lateral view of the piece. The palate plate and drum are composed of fine gold, and made very light.

At the time Mr. Rowell constructed this obturator, we are assured, by Dr. Griscom, he had never heard of nor seen "Delabarre's proposed operation," so that it would seem that the obturator which he constructed was original with himself. We are also informed that it has been worn for six years (1841 to 1847), without causing any appreciable increase in the size of the opening. That this, however, will ultimately be the case, we think there can be no question.

Dr. Mütter gives an engraving of an artificial palate, complicated with several artificial teeth and a metallic velum connected with the palate by means of a hinge, constructed by Mr. Neil, a dentist, of Philadelphia, which is represented as having answered an excellent purpose.* It is difficult to conceive, however, how a gold plate of an oval shape could be made to perform

* Vide Liston's and Mütter's Surgery.

the functions of the velum palati. So far as an imperfection in the hard palate is concerned, the evil, we know, may be remedied by covering the opening with a metallic plate, but the loss of the soft palate cannot be replaced with any hard unyielding material, so as to restore the functions of the natural parts.

The most complicated and, at the same time, ingenious piece of mechanism, of which we have ever heard, for replacing the loss of the entire palate, including the velum and nearly all the teeth of the upper jaw, was invented by M. Delabarre; but in consequence of its weight, from the amount of material in it, as well as the complicated structure of the instrument, it failed to realize the sanguine expectations of the inventor, although he states that it fully answered the purpose for which it was designed. Subsequent experiments, however, have been less successful, and as this method of constructing artificial palates has long since been abandoned, we do not think it necessary to quote the description which he has given of it.

Instead, therefore, of employing this complicated instrument, a simple palate plate, with a velum like the one constructed by Mr. Stearns, or that made by Dr. Kingsley, or with Hullihen's or Blandy's valve, and having artificial teeth attached to it, will be found to answer a much better purpose, in cases such as that for which M. Delabarre's complicated piece of mechanism was prepared. As it is not probable that such an appliance will ever be constructed again, we do not deem it necessary even to copy the engraving furnished by the author.

M. Desirabode proposes a kind of platina obturator for congenital fissure of the palate, by which he thinks the sides of the alveolar border may be so approximated as to favor the union of the divided parts. It consists of a platina plate fitted to the vault of the palate and fastened to the teeth by means of three crotchets (clasps), soldered to each side, so as to cap the canine teeth, the bicuspids, and two of the molar teeth, bent upon the alveolar border, in such a manner as to maintain the whole pressure. After the plate, with these appendages, has been well adapted, it is divided from before backward along the median line, and then a piece is removed from each side, so that the two edges may be separated about half an inch from each other. The two half plates are now united by means of a thick

and resisting band of caoutchouc, made fast by riveting. The plates, thus united, form a smaller obturator than the plate before it was divided, so that it can only be applied by putting the caoutchouc upon the stretch, which is effected by means of two stocks, so contrived as to force the two plates asunder. After the plate is properly adjusted, these are removed, when, by the contraction of the caoutchouc, the sides of the alveolar border are gradually made to approach other.

It sometimes happens that an imperfection of the palate is accompanied by an opening into the maxillary sinus. In this case, the palatine plate should be large enough to close both openings, and the loss of the alveolar border replaced by means of a raised plate, soldered to the lower surface of the palate plate, and to which artificial teeth may be attached.

Such irregularities, and other deficiencies of the hard parts can be most perfectly supplied by the use of a vulcanite plate. The more pliant forms of this material are the best that can be used for artificial vela and movable plates; while for the fixed base, with or without teeth, no better material can be found than the ordinary dental vulcanite, which is peculiarly adapted to plates of such very irregular surface and outline.

In conclusion, it only remains to observe that the same attention is required to prevent injury to the natural teeth, which serve as a support to an artificial palate or obturator, as to those which are used for the retention of dental substitutes; and as full directions have already been given upon this subject, it is not necessary to repeat them here.

INDEX.

G.

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